Copy 1 of 4

PARAHO-UTE PROJECT

PHASED APPROACH ALTERNATIVE

UBS/EIS

DESCRIPTION

In the Phased Approach, a single commercial retort with accompanying mine and all auxiliaries and offsites, would be constructed and operated for approximately fourteen months before construction commences on the second and third retort modules. Construction of the first retort phase would commence during the second quarter of 1983. The initial construction phase for the first retort and accompanying mine and other facilities will be complete by the third quarter of 1985. The second phase of construction is scheduled to begin in the third quarter of 1987 and to be completed in the second quarter of 1990.

Operations are scheduled to begin in the fourth quarter of 1985 with the initial commercial size Paraho retort. The second and third commercial Paraho retorts are scheduled to be online in the third quarter of 1989 and 1990, respectively. Production capacity at full operations will not exceed the hydrotreated shale oil output described in the high-level scenario. A timetable of phased approach alternative is provided in the Paraho-Ute Project Technical Report, Section 4.1.

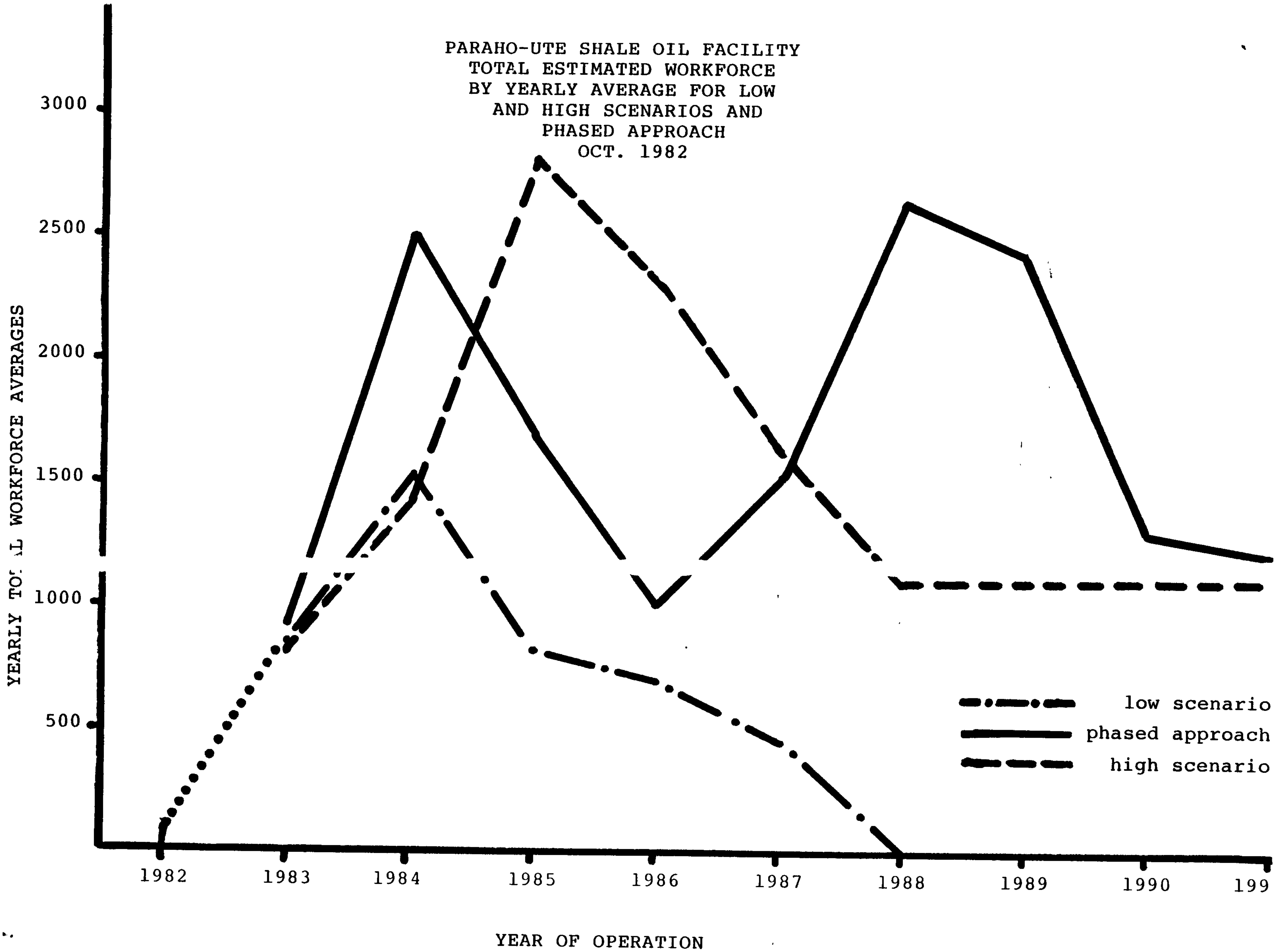
IMPACTS

The overall impacts caused by the Phased Approach are not significantly different from those described under the High-Level Scenario. Total resource requirements - oil shale resources, rights-of-way, water - would not differ. Peak employment would be less. Overall, the employment estimates for the high-level and low-level scenarios, discussed in the DEIS, bracket the employment estimates calculated for the Phased Approach.

This Phased Approach, although having no significant effect on resources, rights-of-way, or anticipated full level of production, does affect the estimated workforce profile for the project (see attached figure). The most apparent change in the work force profile is the presence of two peaks resulting from the construction work force. However, since most of these workers are expected to reside at the temporary, on-site camp, impacts on the local infrastructure from peak

Impacts, continued

employment should be minimal. Also, peak levels are less than those projected for the high level scenario and the growth rate to the second peak occurs later than that for the High-Level Scenario. Both of these factors should reduce the socioeconomic impacts described for the High-Level Scenario. The operations work force for the Phased Approach is not changed significantly from the High-Level scenario. The major change is that nearly twice as much time is required to reach the final level under the phased approach. Those permanent employees require homes, schools, water, and other infrastructure resources. Because of the Phased Approach, more time would be available to meet these increased needs with taxes generated from the facility and secondary sources, and the overall socioeconomic impacts would be minimized.


PARAHO-UTE SHALE OIL FACILITY
TOTAL ESTIMATED WORKFORCE
BY YEARLY AVERAGE FOR LOW
AND HIGH SCENARIOS AND
PHASED APPROACH
OCT. 1982
YEARLY TOTAL WORKFORCE AVERAGES
3000
2500
2000
1500
1000
500
1982
1983
1984
1985
1986
1987
1988
1989
1990
199
YEAR OF OPERATION
low scenario
phased approach
high scenario

PARAHO-UTE PROJECT

COMMUNICATIONS ALTERNATIVE

UBS/EIS

DESCRIPTION

An alternative to the microwave system (DEIS, page P-1-18) is being considered to meet communications needs. Discussions have been held with Mountain Bell to provide telephone service using a buried cable from Vernal to the Paraho-Ute site.

Although various alternative routes are under consideration, the preferred route would follow the new road from Vernal to Bonanza with the cable buried in the shoulder of roads within existing and proposed rights-of-way. It is anticipated that Mountain Bell would design the route, apply for necessary permits and approvals, and perform the installation. The preferred route would allow Mountain Bell to provide service to the Bonanza Power Plant and upgrade service to the town of Bonanza.

IMPACTS

Impacts resulting from the underground cable should be minimal. The cable will be placed in the shoulder of a road within existing and proposed rights-of-way, disturbing no additional vegetation or important cultural, archeological sites. Permanent disturbance would be insignificant.

PARAHO-UTE PROJECT
ALTERNATIVE WATER SUPPLY
UBS/EIS

DESCRIPTION

Since plans for construction of the White River Dam has been delayed so that water from the reservoir will not be available before early 1987, the State of Utah has expressed its intent to work with Paraho to provide construction water out of the State's pending application for appropriation from the White River during the construction phase of the Paraho-Ute Project. Negotiations with the Utah Division of Water Rights for the purchase of water both during the construction and operational phases of the Paraho-Ute Project are anticipated to be concluded by early 1983.

In order to provide an alternative source of water from the White River pending completion of negotiations with the Utah Division of Water Resources and completion of construction of the White River Dam, Paraho is also pursuing negotiations with Sohio Shale Oil Corporation and Cliffs Synfuels, Inc. for the right to use 4.0 cfs of water out of their approved appropriation from the White River. Concurrently, Paraho has initiated discussions with American Gilsonite Company concerning use of up to 1.5 cfs of water out of its existing water right from the White River during construction of the Paraho-Ute Project. Paraho is preparing applications to be filed with the Utah Division of Water Rights for temporary appropriations of an average of 1.5 cfs of water to be used during construction of the Paraho-Ute Project.

Water obtained from one or more of the above sources would, under this alternative, be transported to the site of the Paraho-Ute Project via pipeline from an inlet structure to be located on the White River in the south half of Section 1, T 10 S, R 24 E (the "Section 1 Alternative"). (See attached map.) Prior to completion of the Section 1 Alternative, Paraho would withdraw the limited amounts of water required for initial construction activities (estimated to be less than 0.5 cfs) either through the existing American Gilsonite Company system at Bonanza, Utah, or through temporary pumping facilities to be located at the site of the White River Bridge near Ignatio or at the Section 1 site. Water withdrawn from any of these sites would be transported by truck over existing roads to the Paraho-Ute Site.

The Section 1 Alternative would require acquisition of a right-of-way for a river inlet structure, access roads, buried water pipelines, electrical transmission and data communication lines and off-site reservoir storage. The access roads, pipeline and transmission lines would be located in a common corridor approximately 200 feet in width extending roughly 4400 feet through the south half of Section 1, T 10 S, R 24 E, and roughly 5800 feet within Section 31, T 9 S, R 25 E. The total area included within this right-of-way corridor would be approximately 45 acres, of which less than 20 acres would be disturbed by construction. An additional 5 acre site adjacent to the White River would be included in the right-of-way for the river inlet structure to be located in Section 1, of which less than 2 acres would be disturbed by construction. All but 5 acres underlying the completed access roads and inlet structure would be reclaimed following initial construction activities.

Construction of an inlet structure on the White River will require a permit from the U.S. Army Corps of Engineers pursuant to Section 404 of the Clean Water Act. Paraho will file a separate application for this permit. Included in the design plans for this inlet structure are measures designed to minimize the impact of the structure on endangered and threatened aquatic and botanical species. (Sketches of the proposed inlet structure are attached.) Upon completion of the White River Dam and Reservoir, the pumps and pump housing would be removed and the proposed inlet structure would be abandoned. Water would thereafter be withdrawn directly from the White River Dam by means of movable submersible pumps located on the inclined bank of the reservoir above the proposed inlet structure.

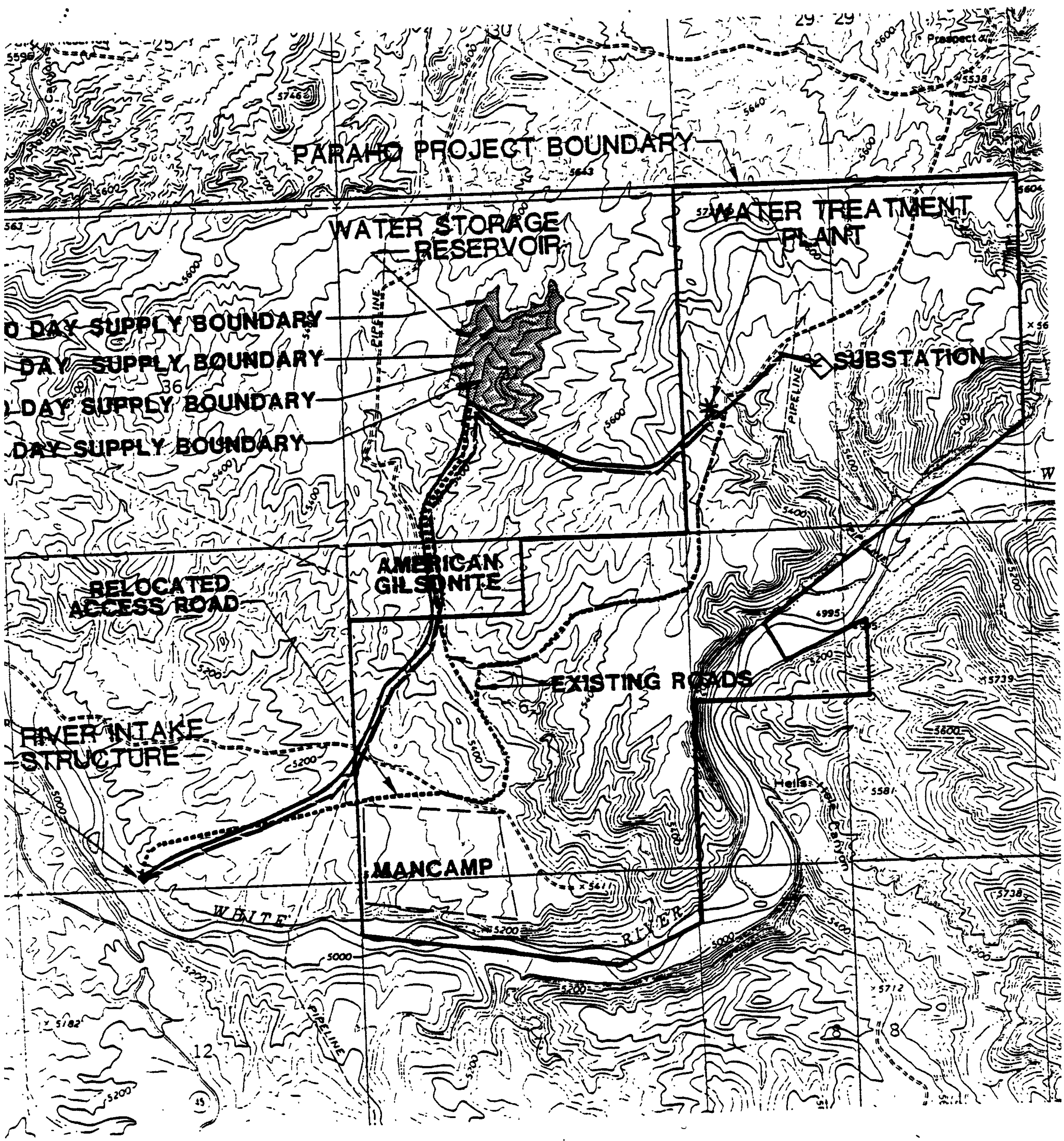
In order to reduce the impacts on aquatic biota and to recognize federally reserved water rights claimed by the Ute Indian Tribe, as well as, to provide "back-up" water for the Paraho-Ute Project during periods of low stream flow or mechanical failure, Paraho proposes to construct a reservoir for storage of raw river water approximately in the center of Section 31, T 9 S, R 25 E. (See attached map.) This reservoir would require an areal right-of-way affecting approximately 75 acres of land, of which roughly 60 acres would be inundated by the reservoir. The proposed design of facilities to be located on the Paraho-Ute Site would not allow adequate room for construciton of a reservoir of sufficient size to provide the 100 days storage capacity for full scale operation of the Paraho-Ute Shale Oil Facility that may be required if the White River Dam is not constructed. Construction of the White River Dam would substantially reduce the water storage requirements of the Paraho-Ute Project to a 7 to 10 day storage requirement. A reservoir adequate to contain that supply for the Paraho-Ute Project would require an areal right-of-way affecting roughly 15 acres of land, of which less than 10 acres would be inundated.

Construction of the White River Dam would substantially reduce the impact of the storage reservoir in Section 31 proposed under this alternative.

IMPACTS

The selection of the diversion site and the location of the storage pond were based, in consultation with the U.S. Corps of Engineers and U.S. Fish and Wildlife Service, on the careful analysis of many sites. More than ten alternate sites and plans were considered before the final selections. The corridors selected were based upon overall assessment of probable impacts, water availability, and water quality. The corridors for the proposed diversion site, the lineal right-of-way, and impoundment pond are situated, for the most part, within the BLM access corridors and have been surveyed to a limited extent as part of the Paraho-Ute baseline assessment. However, prior to final site selection within the selected corridors, an on-site visit will be made by Paraho's engineering and environmental consultants, along with a certified archeologist and paleontologist and members of the Corps of Engineers, Fish and Wildlife Service, and Bureau of Land Management. This on-site visit will be made to reduce potential impacts by avoidance, whenever possible.

Additionally, the inclusion of a 100-day holding pond, is designed, in part, to mitigate impacts to low flow conditions, should the White River Dam not be constructed.

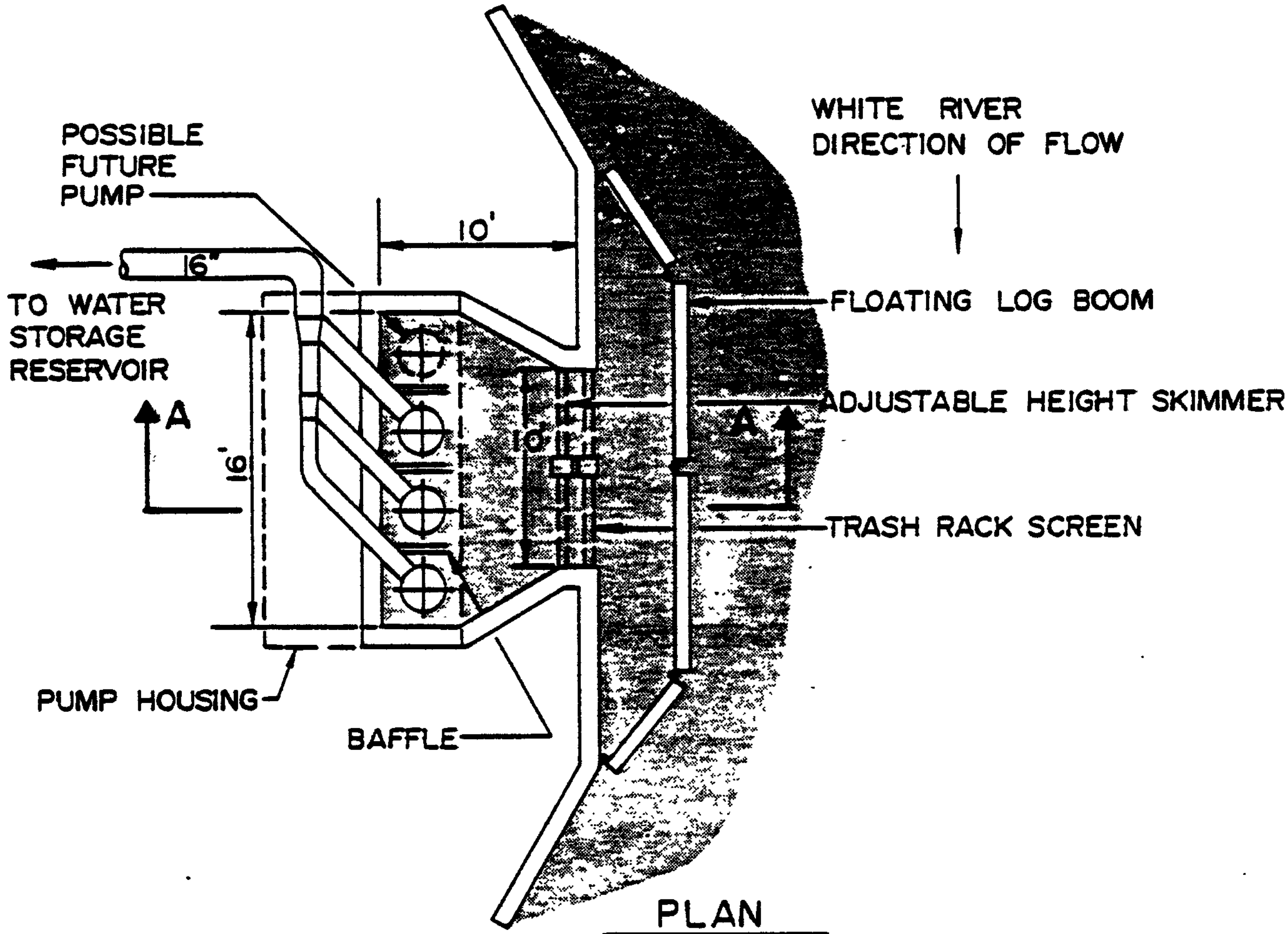


KEY

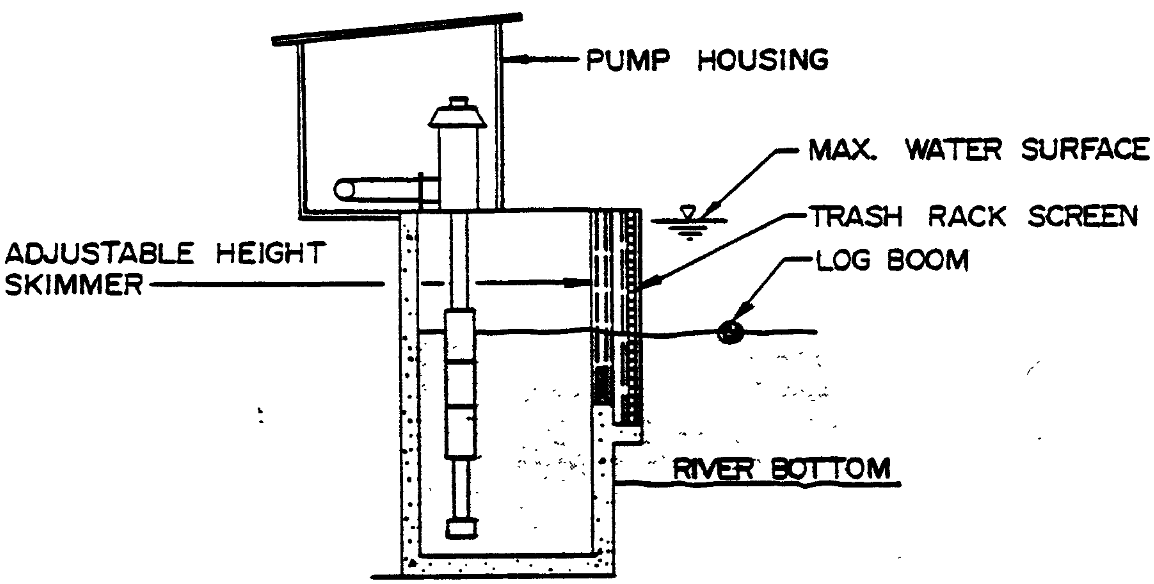
PROPOSED WATERLINE ROUTE

PROPOSED ACCESS ROAD

PROPOSED POWER AND COMMUNICATION LINE ROUTE



PLAN
1" = 10'



CROSS SECTION A-A
1" = 10'

RIVER INTAKE STRUCTURE & PUMPING STATION

PARAHO-UTE PROJECT

ADDITIONAL LANDS ALTERNATIVE

UBS/EIS

DESCRIPTION

Besides the 1416 acres of land included in the Paraho-Ute Site described in the High-level Scenario (shown as the central contiguous dotted area on the enclosed map), Paraho has acquired control of 600 additional acres of land (the "Additional Paraho Land") near the Paraho-Ute Site (shown as dotted areas on the perimeter of the enclosed map). In order to "block-up" its current resource position, Paraho is also finalizing agreements covering approximately 3240 acres of land near the Paraho-Ute Site to be transferred by the Bureau of Land Management ("BLM") to the State of Utah and preferentially leased for oil shale to Paraho. These BLM lands would be acquired by the State of Utah through exchange procedures pursuant to Section 206 of FLPMA and through an indemnity or in-lieu lands selection process pursuant to 43 U.S.C. Sections 851 and 852 (the "State Exchanges"). Paraho has also initiated discussions with the American Gilsonite Company ("AGC") concerning the acquisition of the right to mine the oil shale resources underlying AGC's patented gilsonite claims (the "AGC Lands") extending into the Paraho-Ute Site. When combined with the lands presently controlled by Paraho, these State Exchanges and AGC Lands would form a contiguous, mineable block encompassing approximately 5600 acres. The estimated oil shale resource included within this 5600-acre block would support full scale operation of the Paraho-Ute Project for over 30 years.

The Additional Paraho Lands consist of two Utah State Leases for Oil Shale covering approximately 440 acres, assigned to Paraho by the Atlantic Richfield Company (the "ARCO Lease") and by Emery Coal, Inc. (the "Emery Lease"), together with an interest in 160 acres of privately owned lands purchased by Paraho from Mr. Jeffrey Townsend (the "Townsend Lands"). The ARCO Lease (No. ML-24157) was issued effective March 27, 1967, and encompasses approximately 400 acres of land located in the northern part of Section 36, T 9 S, R 24 E. The Emery Lease (No. ML-35891) covers roughly 40 acres of land located in the southwest quarter of Section 36, T 9 S, R 24 E, and was issued effective July 17, 1978. The Townsend Lands consist of 160 acres of patented mining claims situated in the north half of Section 28, T 9 S, R 25 E, and were purchased by Paraho on March 16, 1982. In order to obtain access to the approximately 600 acres of Additional Paraho Lands for future mining operations, Paraho will be required to either complete the pending State Exchanges or to obtain rights-of-way across the intervening AGC and BLM lands.

Description (Cont'd)

The State Exchanges (shown as diagonal lines on the attached map) will be accomplished in two phases. Under the first phase, Paraho entered into an agreement effective October 6, 1982, to lease certain unpatented oil shale claims currently held by Gulf Oil Corporation and Mr. Fredrick H. Larson ("Gulf/Larson") located in parts of Sections 28 and 33, T 9 S, R 25 E. Paraho is in the process of finalizing an agreement with Gulf/Larson covering certain additional unpatented oil shale claims located in parts of Sections 19, 30 and 31, T 9 S, R 25 E. At the request of Paraho and Gulf/Larson, the Utah Division of State Lands has selected the approximately 1320 acres of land subject to the Gulf/Larson claims as indemnity or in-lieu lands. It is anticipated that final arrangements for transfer of ownership of the underlying lands from the BLM to the State of Utah will be completed by early 1983. Concurrently with completion of this transfer, Paraho will transfer the Gulf/Larson claims to the State of Utah in exchange for Utah State Leases for Oil Shale covering these lands.

Under the second phase of the State Exchanges, Paraho is finalizing an agreement with Amoco Minerals Company ("Amoco") to acquire three Utah State Leases for Oil Shale (Nos. ML-20679, ML-20680, and ML-20682) covering 1920 acres of land located in Section 36, T 10 S, R 23 E, and Sections 16 and 32, T 10 S, R 24 E, respectively. Paraho has held favorable discussions with the State of Utah, the Mineral Management Service, and the BLM concerning exchange of the 1920 acres of land subject to these Amoco leases for certain BLM lands containing equivalent oil shale resources located in parts of Sections 19, 30, 31, and 33, T 9 S, R 25 E, Section 25, T 9 S, R 24 E and Section 1, T 10 S, R 24 E. (The lands to be acquired in exchange for the Amoco leases are included in the area shown as diagonal lines on the attached map.) The exact amount of acreage required for an exchange of equivalent resources remains to be determined. It is currently anticipated that this phase of the State Exchanges would not be completed before early 1983.

Included within the area encompassed by the State Exchanges is land covered by patented gilsonite claims owned by the American Gilsonite Company ("AGC"), a subsidiary of Chevron Resources Company. Paraho has initiated favorable discussions with AGC concerning the acquisition by Paraho of the right to mine the oil shale resources underlying AGC's claims located in parts of Section 30, 31 and 32, T 9 S, R 25 E, and Section 25, T 9 S, R 24 E. (The AGC claims are included in the area shown as diagonal lines on the attached map.) AGC has stated its intent not to impede development of the Paraho-Ute Project pending

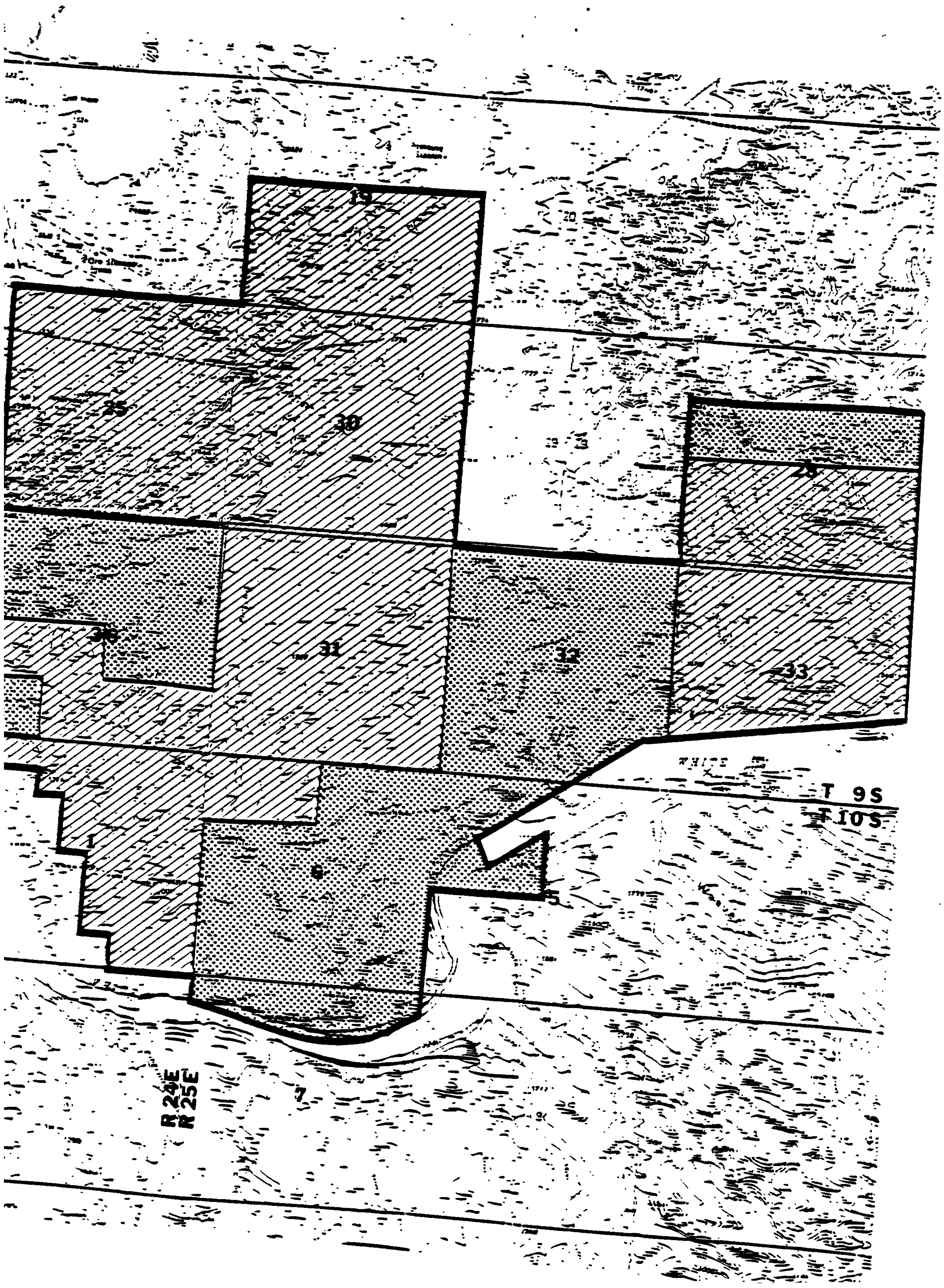
Description (Cont'd)

completion of this agreement, and to grant Paraho such rights of access across the AGC claims as may be reasonably necessary.

IMPACTS

The development of the additional lands will provide sufficient reserves to increase project life from 10 years (High-Level Scenario) to more than 30 years. The plant site and the level of operations (approximately 40,000 barrels per day) will not change. Production details, operating practices, rights-of-way, utility consumption, and work force requirements will remain essentially the same as those described under the High-Level Scenario. The nature of impacts, such as the air emissions, would remain the same, but would continue for a longer period, however, because of the increased distances to property boundaries, off-site increment consumption would be lessened. Retorted shale disposal areas would increase overall. However, with concurrent reclamation of completed sites, the impacts from unreclaimed surfaces at any time, would not change significantly from the High-Level Scenario.

Positive aspects associated with the development of additional lands are the additional domestic fuels produced, the longer term of stable employment in the region, and the longer term of a stable tax base to support the infrastructure.



19
25
30
28
36
31
32
33
T 9 S
T 10 S
1
6
5
7
R 24 E
R 25 E

NEW REFERENCES

Madsen, J.H., Jr. 1981. Supplementary paleontological survey report for the Paraho-Ute project site, Uintah County, Utah. Montrose, Colorado: Nickens and Associates.

Russell, P.L. 1980. History of western oil shale. East Brunswick, New Jersey: The Center for Professional Advancement.

Tucker, G.C., Jr. 1982. A cultural resource inventory of lands for the proposed Paraho Commercial Shale Oil Project, Uintah County, Utah. Montrose, Colorado: Nickens and Associates.

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PARAHO DEVELOPMENT CORPORATION

FOR THE GOOD OF MANKIND

RECEIVED
OCT 29 1982
DIVISION OF
OIL, GAS & MINING

October 27, 1982

Mr. D. W. Hedberg
Division of Oil, Gas and Mining
4241 State Office Building
Salt Lake City, UT 84114

Dear Wayne:

Enclosed are Paraho's responses to the Division's Apparent Completeness Review of Paraho's Mine Permit Application and Reclamation Plan, with the Paraho Commercial Feasibility Study Task 17, Abandonment Plan as the attachment to the responses.

The enclosed responses are based upon discussions held at the meeting with OG&M in September 2, 1982. We feel they adequately address all concerns and look forward toward proceeding to final approval.

Please let us know when we may be of further assistance to you.

Sincerely,

Linda K. Limbach

Linda K. Limbach
Environmental Specialist

LL:ks

enclosure

STATE OF UTAH
NATURAL RESOURCES & ENERGY
Oil, Gas & Mining

RECEIVED 8-23-82

4241 State Office Building • Salt Lake City, UT 84114 • 801-533-5771

August 20, 1982

Mr. Harry Pforzheimer, Jr.
Chief Executive Officer
Paraho Development Corporation
Enterprise Building, Suite 300
101 South Third Street
Grand Junction, Colorado 81501-2498

RE: Apparent Completeness Review
of Mining and Reclamation Plan
Paraho-Ute Shale Oil Facility
ACT/047/003
Uintah County, Utah

Dear Mr. Pforzheimer:

The Division has completed the preliminary assessment of the Mining and Reclamation Plan (MRP) for the proposed Paraho-Ute Shale Oil Project. The following enclosure lists the sections found to be deficient in the plan.

If, upon review of this document your staff has questions, please contact us to clarify any unclear areas. If necessary, my staff would be willing to arrange a meeting in our offices to discuss any outstanding issues.

Upon receipt of the requested additional information from your company, we will assess its adequacy and proceed with the completion of the permitting process.

I apologize for any delays or inconveniences we may have created.

Sincerely,

JAMES W. SMITH, JR.
COORDINATOR OF MINED
LAND DEVELOPMENT

JWS/DWH:btb

Enclosure

cc: Bob Heistand, Paraho
Bob Morgan, Dam Safety
Dennis Dalley, State Health
Wayne Hedberg, DOGM
Tom Portle, DOGM
Sue Linner, DOGM
Tom Tetting, DOGM
Dave Darby, DOGM

APPARENT COMPLETENESS REVIEW

PARAHO-UTE SHALE OIL REVIEW
ACT/047/003, Uintah County, Utah

Wildlife and Vegetation

Rule M-3(2)(b)

Wildlife habitat should be included as a postmining land-use and revegetation should be planned for wildlife forage utilization, as well as for domestic livestock utilization. If any riparian habitat is destroyed, it should be replaced with similar habitat, due to its importance to wildlife.

Rule M-3(2)(e)

It is not clear how the two revegetation practices of seeding and transplanting shrubs will go together. Will areas be seeded first, then have shrubs planted in or vice versa? What time of the year will transplanting be done? It is stated that container grown plants will be fertilized and irrigated during the first growing season. What kinds of fertilizer will be used and at what rates? How will it be applied? How much water will be applied and at what intervals? Has any consideration of using mulch to stabilize topsoil and help hold water on reseeded areas been made (other than on steep slopes)?

Will there be any differences in reclamation/revegetation practices between the retorted shale pile, fine shale storage pile and general plant site areas?

It is stated that three test plots on retorted shale are planned early on--what treatments are planned for these plots and what species will be seeded and/or transplanted on each? How will success of these plots be determined? What criteria will be used to determine final revegetation techniques and species?

Rule M-3(10)(12)

Monitoring to determine revegetation success should include more than one vegetation transect on the raw shale and plant site areas for a representative sample.

It is not clear exactly how revegetation on the retorted shale and raw fines piles is envisioned. It seems unlikely that colonization of the side slopes will take place when these slopes are made of highly compacted shale or cement-stabilized retorted shale. The ultimate goal of reclamation should be some revegetation on the entire waste piles, rather than just 70 percent of surrounding cover on the pile terraces and nothing in between. Please comment on this.

In line with the objectives section of the Mined Land Reclamation Act (Section 40-8-12[1][b]), an endangered species survey of the area should be done. The applicant should survey for plants and animals listed federally or by the State of Utah. Any areas that will be disturbed should be covered by the surveys.

According to the U. S. Fish and Wildlife Service (USFWS), an active golden eagle aerie has been located in the cliffs along the White River just southeast of the permit area (within one mile of the project site). How will Paraho's activities affect this nest (possibly submit map showing nest in relation to surface facilities)? If it has been determined or seems likely that there will be an impact, how will this be mitigated?

Soil Removal

Rule M-10(14)
M-3(1)(f)

A map should be provided which relates soil series and/or complex and available soil depth to soils to be salvaged. The applicant should relate the location of surface facilities and areas to be disturbed to this map.

On page 28 and 32 of the MRP the applicant alludes to the segregation of topsoil and subsoil. In a Lithic Torriorthent, little definition by horizon is observed as these are shallow soils. Possibly a slight color and pH change might be observed. What criteria would be used to achieve this separation of topsoil and subsoil and is it economically justifiable to do this?

The applicant states in Section 3.3, Soils, of the Permit Application that Walknolls are low in nitrogen and phosphorous. Nothing with regard to fertility status of the Otero-Gilson complex is indicated. Please provide more baseline soils data. Data should include, but not be limited to, soil texture, pH, electrical conductivity, sodium absorbtion ratio, boron, iron, lead, molybdenum, selenium, zinc, available nitrogen, phosphorous and potassium, soluble calcium, magnesium and sodium. Sampling should be performed by depth, especially in the Gilson series where the indication is that soils get "extremely saline at depth." This information will assist in proper handling of soil materials.

Soil Protection: What measures will be employed to achieve adequate topsoil stockpile protection? Will drainage be diverted away from piles? Will berms be used to retain soil? Will terraces be employed on soil stockpiles? Will seeding and/or mulching be utilized or will other surface stabilizing agents or measures be used?

How will the development and protection of topsoil stockpiles be correlated with Table 4.10? Once a stockpile is established, protected and revegetated, it is usually not desirable to disturb it prior to its redistribution. Given the sequence of activities associated with the disturbance attendant to the proposed fines and retorted shale pile expansion, how will stockpiling activities be correlated to stockpile locations given the desire to minimize the disturbance of existing, protected topsoil stockpiles? Which stockpiles will be increased in volume concurrent with raw shale fines disposal area development and retorted shale disposal area development and which will be static with regard to volume?

1. What is the anticipated final depth of each of the stockpiles?

2. What will be the probable dimensions of each stockpile at its greatest extent?

3. What will be the slope of the stockpiles? Will terraces be employed?

The applicant may best address these concerns by providing topsoil stockpile configurations and cross sections.

Rule M-3(1)(e)(g)

Four surficial soils stockpile sites are indicated along with volume estimations for each site (pages 32 and 33). Only 2 of these sites appear on the surface maps. Please provide an accurate map.

Please expand on the use of rip-rap on topsoil embankments in light of soil protection. To what extent would rip-rap cover the soil? How would it be segregated from the soil prior to redistribution? What effect would its use have on the biological integrity of the stockpile? A diverse stand of vegetation can enhance the soil prior to its use for reclamation, thus making it more likely to facilitate revegetation efforts.

Soil Redistribution: In the "Soil Replacement" section (page 42), the applicant states that six inches of coarse material will be used as a buffer strip to prevent upward migration of salts from "saline and sodic waters from the piles."

1. What assurance is there there that this is enough material to accomplish this?

2. It is stated that "fines from rock riprap grading process may be suitable" for this. How was this determined?

3. What is the chemical nature of this material? Is it saline or sodic?

The applicant states that 14 inches of soil will be used to cover the above material as well as all graded surfaces. Is this correct?

1. The implication is that soils will be replaced in the area from where they were stripped. Is this correct? If so, how will this be ensured?

2. The applicant states that the mine operation area will be 705 acres. To replace soil to a depth of 14 inches, the operator would require 1,326,967 cubic yards of soil. This leaves a deficit of approximately 270,000 cubic yards. Please clarify.

3. The above does not account for the roads or drainage systems. What are the reclamation plans for these areas?

On page 42 the applicant states that soil compaction which occurs incident to regrading, will approximate that in "layers in natural surrounding soils". What is the baseline bulk density of the surrounding soil? What method(s) will be employed to measure compaction after regrading?

On page 47 the applicant alludes to the possibility of winter soil redistribution with spring seed bed preparation. The Division is of the opinion that these activities should occur in fall for the the following reasons:

1. The moisture content of soils would be maximum during winter/spring redistribution activities. This increases the likelihood of excess soil compaction and negative effects on soil structure.

2. Wind and rainfall patterns may be such that the potential for excessive erosion would be heightened.

3. Handling soils at these times would result in greater exposure of soil (more surface area), thus loss of valuable soil moisture critical to seed germination.

Rule M-3(2)(c)
M-10(6)

More detail is needed on waste rock handling. The applicant states that all waste rock will be used as riprap (page 35). What will be the duration of this intended usage? How does it relate to the regrading plans on site abandonment? Will this volume be required to achieve approximate original contour (page 38)? In either event, the Division requires information concerning its potential chemical effect on revegetation and/or runoff water quality. If it is highly saline or alkaline it could have adverse effects. Possibly a minimal sampling scheme (pH and EC) could provide an indication as to the necessity of performing additional tests.

Rule M-10(12)

Will any contemporaneous reclamation of the retorted shale disposal area be carried out?

Why was a sprinkler system chosen as opposed to another form of irrigation? The efficiency of water use could be improved by utilizing a trickle irrigation system. Please comment.

v

Hydrology

Rule M-3(1)(e)

The applicant has shown plans to control runoff from raw shale storage and retorted shale piles. The applicant will need to submit similar plans for controlling runoff from the disturbed and undisturbed areas on and adjacent to the proposed processing facilities.

Specifically, the design plans should include maps and typical cross-sections of the drainage control structures to be implemented to handle the disturbed and undisturbed runoff.

Design calculations should be included which demonstrate that the proposed structures can accommodate (at a minimum), the runoff volume from the 10-year, 24-hour precipitation event.

The design maps should designate locations and sizes of culverts, diversion channels, sediment ponds, berms, etc. The direction and general gradient of the surface drainage flow should also be indicated on the map(s).

The designs for the sedimentation ponds should demonstrate adequate stability (i.e., combined embankment slopes of 5H:1V, stability factor of 1.5 or other acceptable standard engineering methods).

It is recommended that the sedimentation ponds be provided with an emergency spillway to prevent possible failure in the event of a significantly large rainfall event (i.e., spillway should safely pass the discharge from a 25-year, 24-hour storm).

Rule M-3(1)(h)

Applicant must indicate methods to be employed to ensure compliance with the State and Federal effluent standards, prior to discharging runoff or mine waters from treatment facilities into the receiving streams.

Does Paraho plan to develop any wells to obtain water from the Birdsnest aquifer or any other aquifer?

What water will Paraho use in the mining operation, how much, will any be discharged, how will it be contained and what will its quality be?

Will the Paraho operations have any impact on the ground water wells owned by American Gilsonite? Why or why not?

Rule M-5(d)

The applicant should submit plans that will be employed at the cessation of mining operations which insure that the access and intake shafts be sealed in a manner that will prevent interflow of ground water from the Birdsnest aquifer to mine workings and other strata below.

Rule M-10(2)(b)(6)

The applicant states on page 21 of Attachment B of the MRP, that "miscellaneous trash and other refuse" from the plant, mine and construction camp will be disposed of in the retorted shale disposal pile.

The Division questions what the miscellaneous trash and other refuse materials will be.

The applicant will be permitted to dispose of only inert materials in the retorted shale pile. Disposal of other hazardous, toxic or acid-forming wastes must be disposed of in accordance with the standards established by State Health and/or the U. S. Environmental Protection Agency (EPA) federal regulations.

The applicant needs to provide a means for controlling the runoff from the proposed sanitary landfill sites.

Geology

Rule M-3(1)(e)

In development of the ventilation intake adits and inclines, will the Birdsnest zone be sealed off, i.e., cemented or controlled, should excessive seepage or flow be encountered, or simply pumped for usage underground?

Rule M-3(1)(g)
M-10(2)(b)

Figures determining the adequacy of sizing for disposal of foundation concrete, etc., in "basins" or waste water treatment ponds have not been included. It has also been stated that certain "retention ponds" may remain after reclamation. It is not clear which "ponds" or "basins" will be used for disposal of materials and whether adequate storage volume is available. Figures or plans should be presented specifically detailing this portion of the proposal in light of Rule M-10(9).

Rule M-3(2)(c)

American Gilsonite property is indicated to exist under the raw shale reject/fines storage pile. Do these pieces of property contain seams of gilsonite? Have they been mined out? If so, to what depths? Is storage of fines planned in these seams if they are available? Will American Gilsonite Company need to sign off on Paraho's operational plans?

Rule M-3(2)(c)

Approximately 300,000 tons of elemental sulfur are estimated to be produced during the operation. Mention was made within the plan of disposal of "unmarketable sulfur" by emplacement into the retorted shale pile. What is the difference between the amount of produced sulfur and the "unmarketable" amount? In essence, what figures are available to indicate the amount of sulfur to be emplaced into the waste pile?

Section 40-8-12

Shops and main headings as well as proposed extraction panels, NE1, NE2, SE1, N2-a and N3-a, are located directly under the retorts and main buildings located in Section 32. Subsidence calculations, overburden depths and thickness, and specific total percentage extraction estimates for pillars and ramps, etc., should be provided to the Division for development of mitigation procedures or confirmation of no significant subsidence impact.

Rule M-6

The location of the proposed mine portal access road and site access has not been detailed. An adequate map should be presented that includes final completion location for these items.

The large folded map drawing 8103-GY-GI shows a north-south placement of a retention pond dam while small drawing 8103-GY-GI in Attachment A shows an east-west siting. These are contradictory. Which is the more recent or correct?

Rule M-10(4)

Exposed outer slopes of the shale fines storage area will have a seven percent cement/shale proportion treatment placed upon them as a three foot thick outface zone for stabilization. Will this application require expansion joints to minimize any cracking potential caused by weather and seasonal changes?

Rule M-10(6)

Disposal plans for waste oil products, solvents, etc., should be included in the mine plan proposal. Contractual removal of these materials by a licensed agent is recommended.

Slope Stability and Pillar Design

Rule M-10-4

Cross-sections of the pre-existing and postmining topography are needed for the retorted shale storage pile, the raw shale fines storage and soil piles.

For the reclamation plan, it was noted that "research analyses of pile embankment and slope stability showed high safety factors. The safety factors for the retorted shale pile were well over 2.0 for static stability to 1.75 or over for dynamic stability. The safety factors for the raw shale fines wered 1.0 for static stability and 1.7 for dynamics." What type of methods were used to arrive at these safety factors? The Division would like to check calculations of method used.

Rule M-3(3)

Did the pillar design account for any water that may enter the bed and its effects upon the rocks involved?

Rule M-10(2)

Has the pillar size around gas wells been designed yet? If so, what criteria were used in the development of reasonable safety factors?

Miscellaneous Sections

Rule M-3(1)(d)

The applicant states on page 17 of Attachment B that the buried Mountain Fuel Supply Company pipeline will be adequately protected from the intersection with the diversion cut. What measures will be utilized to insure protection?

Will this pipeline be undermined by the mining operation? If so, what means are proposed to insure that subsidence will not be a problem? Has Mountain Fuel Supply Company been notified and approved of Paraho's plans?

The Division has been in contact with representatives from the Utah Division of State History concerning the present remains of a previously operated and abandoned "retort" located adjacent to the White River Shale Oil Company properties along the south facing slopes of the White River (southwestern corner of permit area).

The site is not considered to be of significant importance to warrant protective measures, however, it is requested that the site be photographed and the location properly documented and delineated on an appropriate topographic map. This information should be submitted to the Division where it will be filed and also forwarded to State History.

Title 40-8-22

Prior to issuance of final approval, the applicant should provide evidence (listing) that permits from other State and Federal agencies have been obtained and/or applied for.

The Department of State Health, Bureau of Water Pollution Control will need to issue a construction permit for the sedimentation ponds. The Division of Water Rights, State Engineer's office will also issue a construction permit for all impoundments as proposed for the operation.

If the applicant proposes any stream diversion or lateralization work to obtain a water supply, a federal Army Corps of Engineers 404 permit may be required. A State Engineer's office approval would also be necessary to permit the diversion point and any change in water use.

This Division's final approval of the MRP will not constitute approval for the other State or Federal permitting agencies.

Bonding

Rule M-5

The Division cannot make an adequate assessment of the reclamation bond at this time, due to the insufficient detail of breakdown in the reclamation costs provided in the plan (page 52-53, Attachment B).

The Division requests a specific breakdown of projected costs which details the unit costs used to generate the figures in Table 5.2.

The Division suggests that Paraho elect to utilize an incremental method in establishing the performance bond. This bond could be adjusted on a regular basis according to the amount of disturbance at any one time. This will also negate the requirement to post the entire performance bond initially.

Paraho should establish a reclamation cost based upon the "phased" development approach. This could require a cost determination based upon a two or three year projected development schedule, or whatever schedule the company and the Division could agree upon.

The Division still needs to have a good estimate of the total overall estimated reclamation costs for the entire project up front for the Board of Oil, Gas and Mining approval.

x

Parahi

NOTICE OF INTENTION TO COMMENCE MINING OPERATIONS

APPARENT COMPLETENESS REVIEW

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LIST OF FIGURES

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Paraho

Wildlife and Vegetation

Rule M-3(2)(b)

The postmining use and revegetation will be planned for wildlife as well as domestic livestock forage utilization. Under current design plans, no riparian habitat will be destroyed.

Rule M-3(2)(e)

The revegetation procedures outlined in Paraho's Reclamation Plan will be researched on the test plot to be located on the retorted shale test embankment. The retorted shale test embankment will be constructed during initial operation of the first retort. The test embankment is designed to 1) determine the stability and strength of the compacted retorted shale and 2) determine the success of the revegetation program outlined in the application (see Drawing TD-G1 of Attachment B, Paraho Reclamation Plan, Retorted Shale Pile Development).

Test plot parameters include: fall and spring seeding and transplanting, range of fertilizer aplication rates, application of water at various rates, application of various types of mulch, and the effect of a capillary barrier. The test plot will utilize topsoil from the disturbed sites over retorted shale. No other test plot is planned. For details of test plot parameters, see Table 1. Statistical input will

TABLE 1

Test Plot Parameters

The same species selection (see below) will be used throughout all treatments (based on BLM site guides) at controls.

Grasses	Forbs	Shrubs
Bluebunch wheatgrass	Scarlet globemallow	Wyoming big sagebrush
Indian ricegrass	Longleaf phlex	Shadscale
Bottlebush squirreltail	Desert pepperweed	Douglas rabbitbrush
Bluegrass		Spiny hopsage
		Rubber rabbitbrush

Parameter	Control	T1	T2	T3
Germination Rate	No Seeding	Fall Seeding	Spring	--
Germination Rate	No Seeding	5 PLS/sq ft	10 PLS/sq ft	15 PLS/sq ft
Effect of Capillary barrier	None	6 inches	12 inches	18 inches
Effect of nitrate amounts tilled into soil before seeding	5 lbs/acre	25 lbs/acre	50 lbs/acre	75 lbs/acre
Effect of super phosphate amounts at constant nitrate amount of 50 lbs/acre	None	25 lbs/acre	50 lbs/acre	75 lbs/acre
Effect of daily water application during growing season by sprinkler	None	.03 cm	.05 cm	1.0 cm
Effect of mulching	None	Straw 1500 lb/acre	Wood Chips 1500 lb/acre	Hydromulching 1500 lb/acre

TABLE 1 (cont.)
EXPERIMENTAL DESIGN

Percent germination will be used as a measure of reclamation success.

Each treatment plot will be designed to test how germination success is affected by the different treatments: time of planting, number of viable seeds per square foot, capillary barrier depth, fertilizer, water application and mulching. Each set of treatment plots will test the effects of one or more of the above parameters on germination success. Each of the test plots will be replicated twice by planting in the spring and the fall. Variation in all parameters tested will be measured, and the results analyzed using a Three Way Factorial. An example statistical and plot design is as follows:

Source of Variation	Degrees of Freedom
Replication	3
Water Application	3
Capillary Barrier	3
Seed Density	3
Water Application x Capillary Barrier	9
Water Application x Seed Density	9
Seed Density x Capillary Barrier	9
Seed Density x Capillary Barrier x Water Application	27
Error	189
Total	255

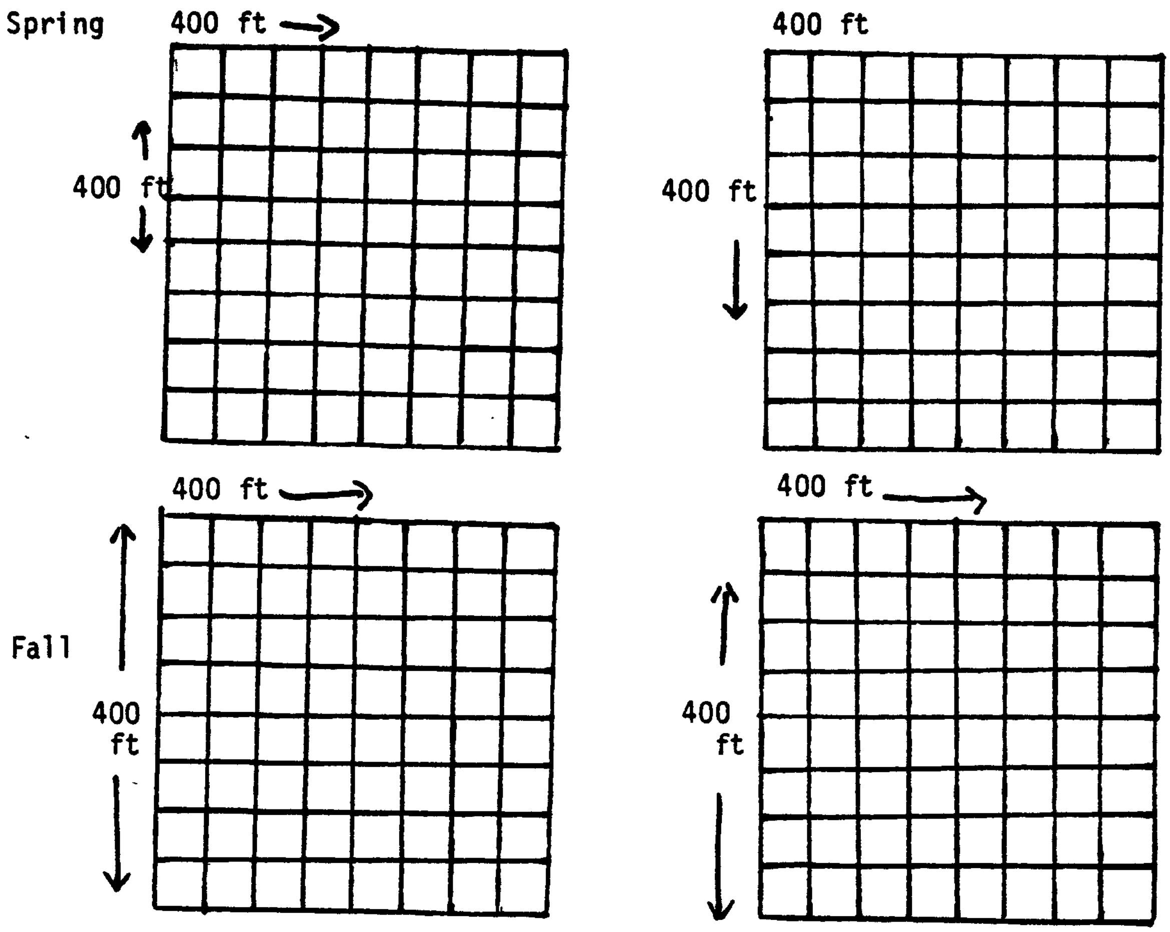
Replication	3
Nitrate-N	3
Super Phosphate	3
Mulch	3
Nitrate-N x Super Phosphate	9
Nitrate-N x Mulch	9
Super Phosphate x Mulch	9
Nitrate-N x Super Phosphate x Mulch	27
Error	189
Total	255

TABLE 1 (cont.)

Statistical Analysis - Three Way Factorial with Interactions

Plot Design - Randomized Complete Block

Example Plot Design



Plots will be planted in the appropriate season and cover and density will be measured at least once a year after the time of planting. The test plots will be sampled over several seasons to determine germination and survival of the planted species.

be used for plot design.

The success of the test plots will be determined by the Division's criteria of achieving a surface cover of at least 70% of the representative vegetative communities. The criteria to determine final vegetation techniques and species are those that, after several years of observation, achieve a 70% surface cover, are economically feasible, and are those procedures that have been demonstrated successfully from the test plot. The reclamation program will consider new revegetation developments throughout management of the test plot. The reclamation plan may not be finalized until results from the test plot are available. Since the test plot will be in place for several years before being inundated by retorted shale, the final reclamation plan would be completed about 1990.

Rule M-3(10(12)

Monitoring of vegetation will include enough transects per area to be statistically valid, assumed to be three 100-foot transects.

The slopes of the retorted shale pile are designed to be steep and covered with natural rock so that the pile will blend in with the surrounding canyons and slopes (see photograph - Figure 1). Also, assimilating natural slopes, the sides of the raw shale storage area is designed to be cement stabilized spritolic ~~riprap~~. The natural canyons have very sparse vegetation so that the pile steep slopes would correspond to the natural canyons. If the retorted shale pile or raw shale fine pile were designed with gentle sloping sides, the area

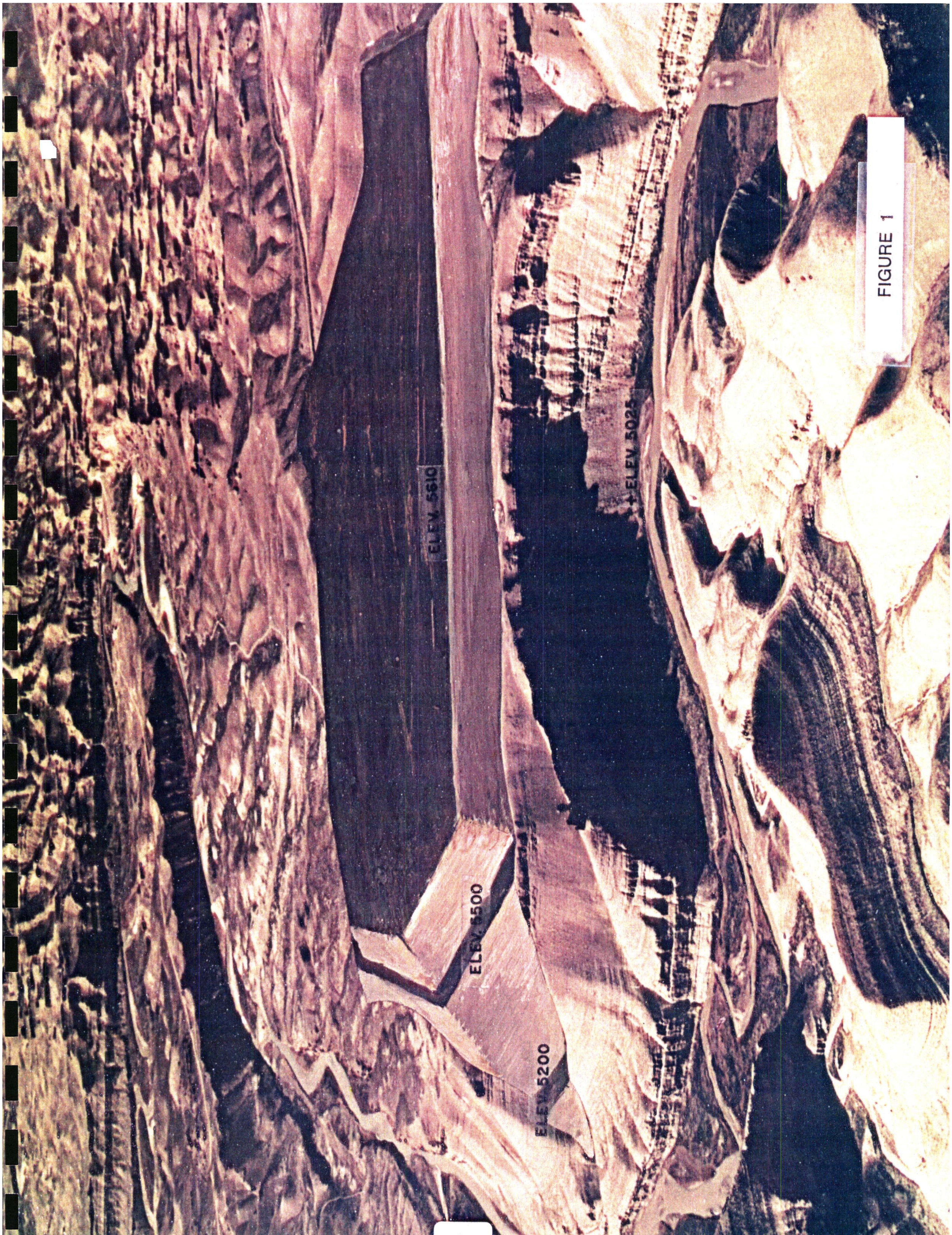


FIGURE 1

disturbed would be extensively increased and would not be as compatible with the surrounding canyon contours.

Field investigations for sensitive plant species were conducted in August of 1980 and in May, 1981. During 1980, general observations were made for sensitive plant species on Section 32, the transmission corridor and selected road corridors. In May of 1981, general observations were conducted on Sections 6 and 32. Also, surveys were conducted along the cliffs of the White River in areas which are considered potential habitat for sensitive plant species.

The most likely sensitive species to be present on the project site (Table 2) is the White River penstemon (Penstemon sp. nova), which is known to occur within one-half mile of the project site. This species is being considered for listing as endangered by the USFWS in 1982.

In the Vernal District of the BLM only one species, the Uinta Basin Hookless cactus, is listed as threatened (England, 1980).

No individuals or populations of the White River penstemon, Uintah Basin hookless cactus, or any other sensitive plant species were found on Sections 6 or 32 during the on-site field surveys conducted in May, 1981. Some areas of suitable-appearing habitat for the White River penstemon were located in some of the washes and along the cliffs adjacent to the White River.

Four wildlife species considered endangered by the U.S.

TABLE 2
SENSITIVE SPECIES IN THE PARAHO REGION

Species	Official Status	Habitat	Location
Cactaceae			
Sclerocactus glaucus Uinta Basin Hookless cactus	Listed as Threatened	Gravelly soils on hills and mesas	Found near the Green River (Welsh and Nesse, 1979)
Scropulariaceae			
Penstemon sp. nova (alba-fluvis? Bechtel, 1981) White River penstemon	Taxa currently under review (to be proposed for listing by USFWS in 1982)	Green River Formation	Along the White River 1/2 mile from the Paraho project site (England, 1981)

Fish and Wildlife Service (USFWS) and the State of Utah have been observed in the Uinta Basin. These are the black-footed ferret (Mustela nigripes), the American peregrine falcon (Falco peregrinus anatum), the bald eagle (Haliaeetus leucocephalus), and the whooping crane (Grus americanus). In addition, the golden eagle (Aquila chrysaetos) which is protected by federal law, the bobcat (Lynx rufus) which is currently protected by state law, and the sandhill crane (Grus canadensis) which is considered limited by the state of Utah (Utah DWR 1979a) are known to occur or have been sighted in the Uinta Basin.

Utah is on the western margin of the historic range of the black-footed ferret. There were several reliable but unverified sightings reported from 1972 to 1975 within the Uinta Basin (Utah DWR 1979a), but it is extremely unlikely that any individuals utilize the project site (Olsen 1973, Crannie, 1983). Only evidence of a historic prairie dog town was found on the site during field observations conducted in August, 1980. It is considered unlikely that the black-footed ferret uses the project site.

Peregrine falcon are known to nest in the Uinta Basin (Crannie, 1980), and several confirmed peregrine falcon sightings were made in 1975 within several miles of the project site (VTN, 1977). Bald eagles winter along the White River in the general vicinity in densities of about 15 to 20 individuals per 10 miles of river (Crannie, 1980). These eagles may occasionally forage in the project area, but none are known to nest in the region (Behle and Perry, 1975).

Both whooping and sandhill cranes have been sighted passing over the project region during their migrations. Based on habitat characteristics, it is unlikely that either species utilizes the project site during migration.

The bobcat population levels in Utah have experienced a statewide decline as a result of excessive harvest. Utah DWR has recently provided total protection, and the state-wide population level seems to have stabilized. Bobcat are expected to utilize the project site to some extent, but no clear indication of bobcat presence was observed during spring 1981 field studies. Use appears to be very low at the present time, possibly as a result of low numbers of small prey mammals.

Initial baseline data indicate that no threatened, endangered or sensitive species will be affected by project development. As a contingency, Paraho is developing a monitoring plan which will provide extensive yearly monitoring for all threatened, endangered or sensitive species which may be found on the project site. This program will be in effect until sufficient data has been gathered which illustrates that project development threatens none of these species.

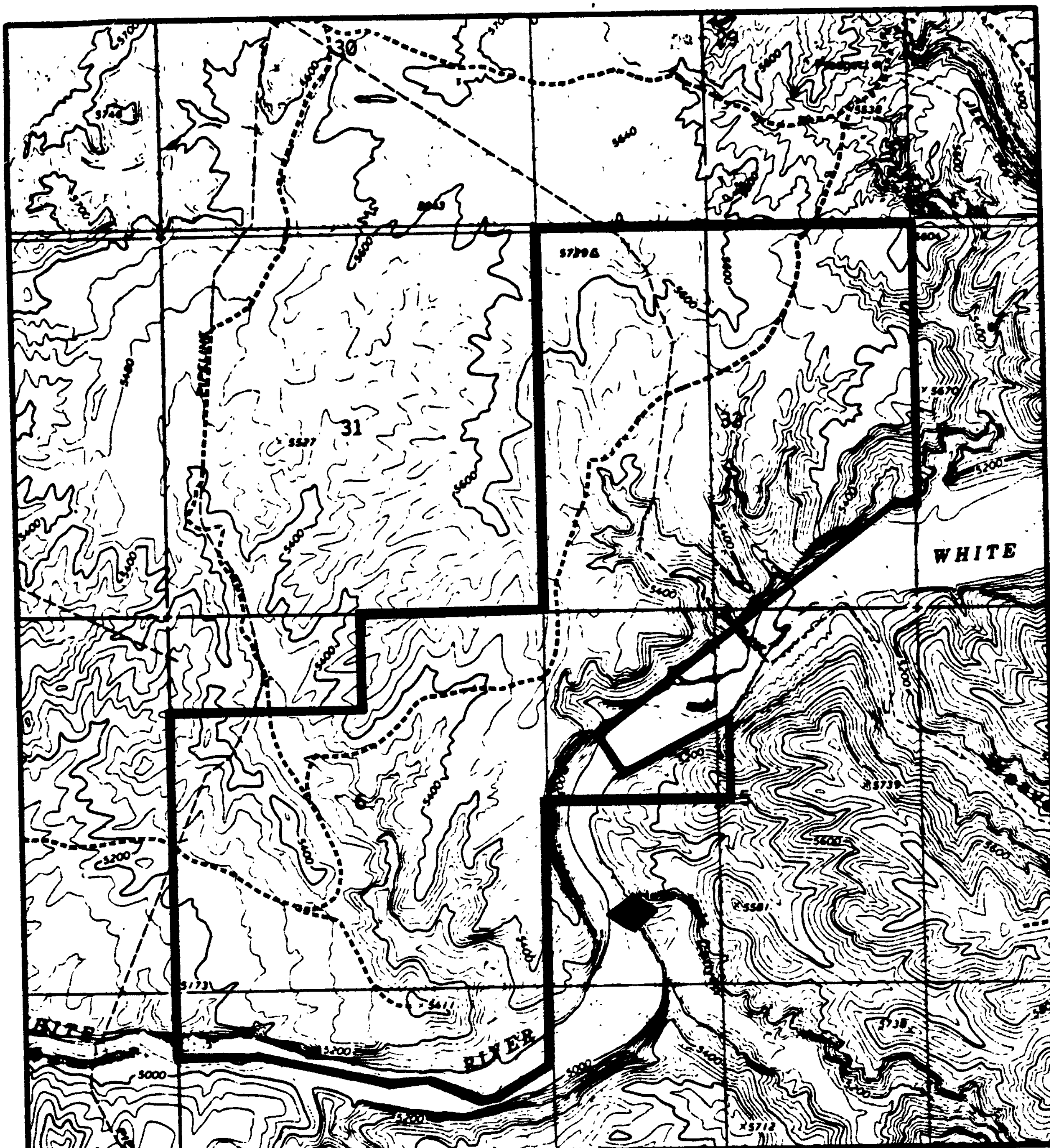
A literature search conducted for Paraho indicated that three endangered fish species may exist in the White River - the Colorado Squawfish (Ptychocheilus lucius), the Humpback chub (Gila cypha) and the bonytail chub (Gila elegans). This study also indicated that there appeared to be little impact of the Paraho project on these species due primarily to its modest water requirements and sedimentation control.

In addition to the above study, a large river project was conducted by the USFWS in conjunction with the proposed White River Dam. This program investigated the potential impacts of dam development on endangered aquatic species and the study resulted in a "non-jeopardy" opinion based on extensive mitigation measures. The study indicated that the White River Dam would not adversely affect those fish populations. In view of this opinion, it would be reasonable to conclude that the Paraho project, which is significantly smaller in scope and potential impact, would likewise not affect endangered fish species.

A more complete discussion on threatened and endangered plants and animals is located in: VTN 1982 "Paraho Commercial Feasibility study, Vegetation Studies Addendum, Task 2 Project Area Description," 62 pp.; and VTN 1981 "Paraho Module Project, Environmental Assessment, Task 7," 283 pp.

A map (Figure 2) has been included which indicates the location of the Golden eagle nest. It is just below Hells Hole Canyon on the south side of the White River.

The nesting activities during breeding season would not be affected by project-related human disturbance. In addition, Paraho's access to the plant site and most intensive development will occur on the north side of the river of the site and thus minimally impact the golden eagle nest. Paraho



LEGEND

PROJECT BOUNDARY

GOLDEN EAGLE NEST

PARAHO-UTE SITE CLOSE-UP

FIGURE 2

N

SCALE: 1" = 2000 FEET
Contour Interval 40 feet

JUN 1982

has formulated a detailed fish and wildlife management plan found in: Paraho 1982 "Commercial Feasibility study: Environmental Analysis, Vol. III." Portions of the Management Plan have been included which address minimizing of impacts to wildlife that are relevant to raptors and the eagle nest activities. The fish and wildlife protection plan is designed to: a) mitigate potential project-related impacts on the important fish and wildlife species found on or near the Paraho project site; b) confine impacts to the immediate project area and to reduce or minimize the duration of impacts. These aims are accomplished through design features, operational actions, and the formulation of a reclamation and revegetation plan to be implemented at the termination of the project.

> Raptors are common throughout the Uintah Basin and are often sighted on or near the project site. Sixteen species have been sighted or occur commonly in the area: turkey vulture, eight hawks, two eagles, three falcons and two owls. All but the rough-legged hawk and the bald eagle nest in the region (UDWR 1974). Raptors are becoming popular in terms of public interest and have significant aesthetic and scientific value (Idaho Department of Fish and Game 1980). Under the Migratory Bird Treaty Act and the Eagle Protection Act, these birds are fully protected from shooting or direct harassment.
>
> Bird species on or adjacent to the site include the red-tailed hawk, rough-legged hawk, golden eagle, bald eagle, marsh hawk, peregrine falcon, prairie falcon, turkey vulture, sharp-shinned hawk, Cooper's hawk, Swainson's hawk, ferruginous hawk, osprey, the great-horned owl and burrowing owl (UDWR 1974).
>
> Possible impacts on raptors include increased shooting of birds and electrocutions from power-lines.

Mitigation measures which will reduce these potential impacts include:

- The facility will have zero waste water discharge of effluent into the White River.
- Riparian vegetation along the White River, which is outside the plant process area, will be minimally disturbed.
- All overhead powerlines will be constructed so as to prevent electrocution of raptors.
- Workers will be bussed to/from the site.
- Prohibition of firearms on-site, education of employees as to wildlife laws and values, and encouragement of employees not to violate wildlife laws.

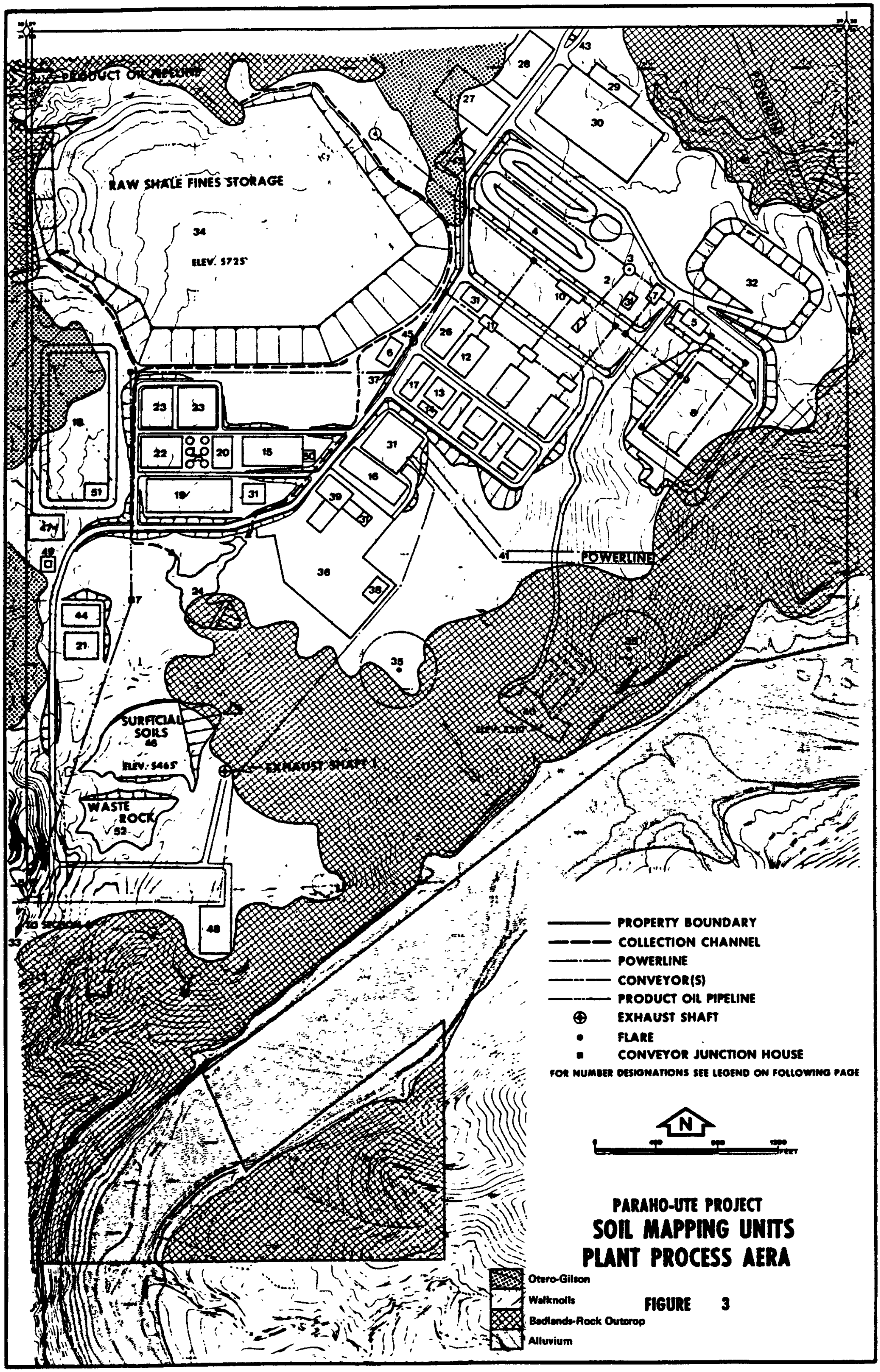
Soil Removal

Rule M-10(14) M-3(1)(f)

Maps which relates soil mapping units and available depth of soils to be salvaged are provided in Figures 3 and 4.

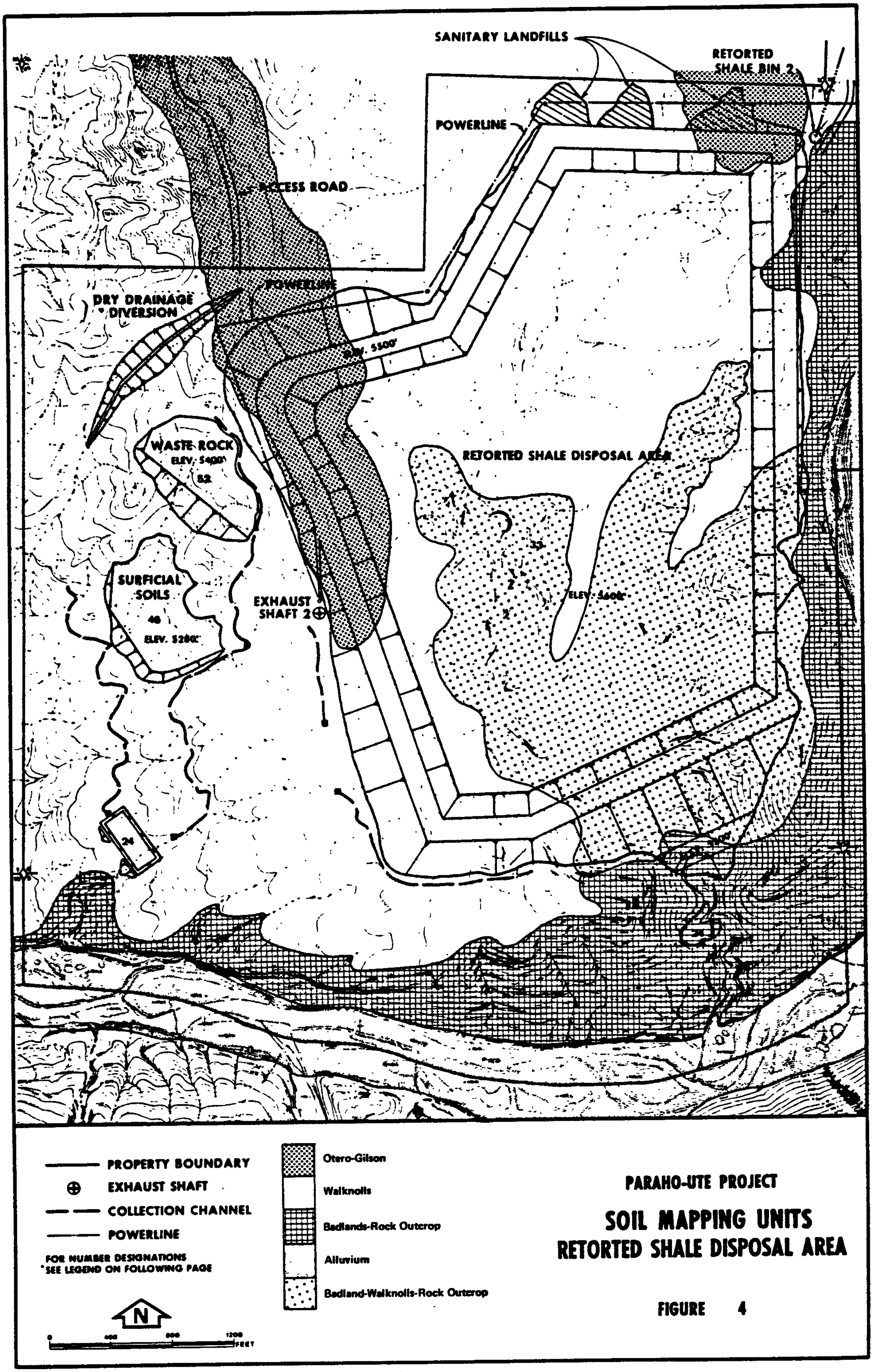
Topsoil and subsoil will not be separated during construction. All these surficial soils to be later used as plant growth media will be handled and treated in the same fashion.

All the baseline soils data collected to date have been compiled in this section. On-site information was collected by Woodward-Clyde Consultants (WCC) and VTN, Consolidated (VTN) as part of field studies carried out during the Paraho Module Program and Commercial Feasibility Study. These site studies complement the Uintah Basin survey being completed by the Soils Conservation Service (SCC). Figure 5 shows the location of site-specific studies. Test pits 6 through 9 (as shown in Figure 5) were sampled by Woodward Clyde Consultants (WCC) as part of their preliminary evaluation and design study. Samples (WCC) points 1 through 5 were chosen by VTN as part of an environmental reconnaissance survey. The two groups were sampled somewhat differently and as they were evaluated independently, some of the chosen series names differ. These taxonomic differences are slight, concerned principally with percent rock fragments in the solum.



PARAHO-UTE PROJECT
SOIL MAPPING UNITS
PLANT PROCESS AERA

FIGURE 3



PARAHO-UTE PROJECT

SOIL MAPPING UNITS
RETORTED SHALE DISPOSAL AREA

FIGURE 4

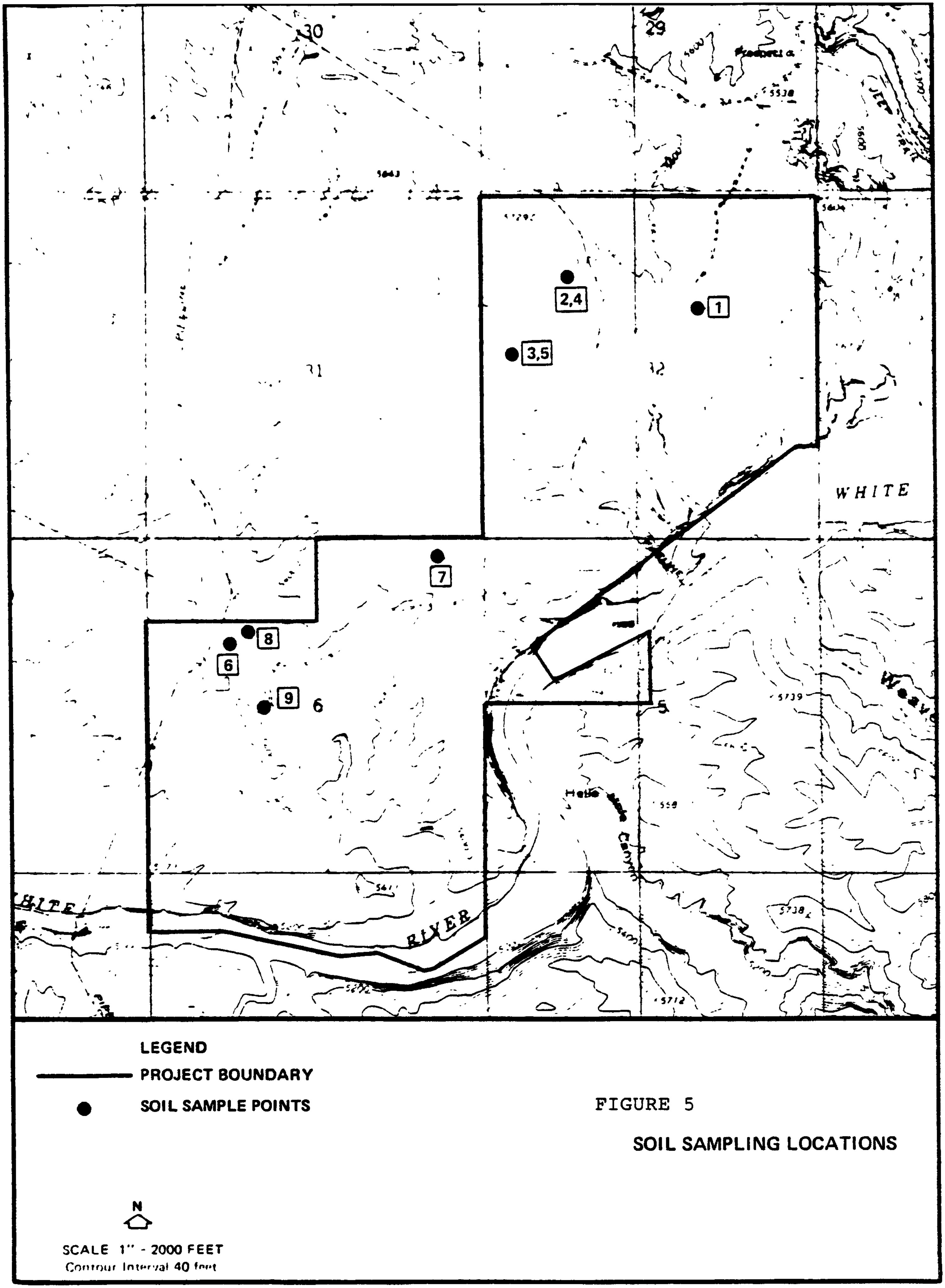


FIGURE 5

SOIL SAMPLING LOCATIONS

The following soils information is taken from:

Woodward-Clyde Consultants 1981. "Paraho Commercial Feasibility Study, Preliminary Design Criteria for a Retorted Shale Disposal Facility."

The soils in this study area are young or very young and are weakly developed or show no development at all. All of the soils in this area are Torriorthents with Lithic or Ustic subgroups. The particle size classes are either sandy, fine-loamy, coarse-loamy, loamy or loamy-skeletal. Course fragments are either sandstone or shale ranging from 2 millimeters to about 25 centimeters in diameter. All of these soils are either well-drained or somewhat excessively drained and range in depth from very shallow (less than 10 inches to bedrock) to deep (greater than 60 inches to bedrock).

The Soil Conservation Service (SCS) soil mapping was reviewed for this area. The SCS has mapped this area at the 3rd order level and calls it Walknolls dry phase. The SCS includes three different soil map units in the area consisting of miscellaneous land areas such as Badland or Rock outcrop, and two soil series, Walknolls and Gilson. WCC performed field investigations on more site-specific basis during March, 1981 to determine the soil series within the study area. Four (4) soil series were found to predominate throughout the study area. These soil series are Farb, Bankard, Gilson Variant, and Shavano. These soils were sampled to 13 feet or bedrock, whichever occurred first. Samples were analyzed by Agricultural Consultants Laboratory of Brighton, Colorado for pH; electrical conductivity (EC); saturation percentage; soluble calcium; magnesium and sodium; sodium absorption ration (SAR); percent lime; and percent by weight of coarse fragments. In addition, particle size distribution was determined for six samples by WCC's laboratory to verify field texture determinations. This chemical and physical data (see Table 3) was analyzed to determine the suitability of the various soil horizons for use during reclamation.

WALKNOLLS DRY PHASE (SCS 1982)

Farb Series - These shallow, well-drained soils are on side slopes of shale controlled hills. The pH ranges from 7.7 to 8.1, EC ranges from 2.8 to 3.3 millimhos per centimeter and sodium adsorption ratio (SAR) ranges from 1.6 to 4.1. The textures typically are sandy loam or shaly loam with 15 to 34 percent by volume, coarse fragments. Saturation percentages range from 28 to 32 and percent lime ranges from 5.8 to 8.7.

This soil, to a depth of 17 inches or bedrock, whichever occurs first, is suitable for stripping and use as surficial soils material. High coarse fragment percentages preclude these soils from being ideally suited for topsoil use.

Bankard Series -Bankard soils are deep, well-drained or somewhat execessively drained soils on the narrow drainageway areas. Soil pH ranges from 7.1 to 8.6, EC from 2.4 to 8.4

TABLE 3

CHEMICAL AND PHYSICAL ANALYSIS OF TYPIFYING SOIL PEDONS

Depth (in)	pH	EC[1] (mmhos/cm)	Ca (meq/l)	Mg (meq/l)	Na (meq/l)	SAR[2]	Sat[3] %	Lime %	Sand %	Silt %	Clay %	Field Texture[5]	Coarse Fragments % (by wt)	Coarse Fragments[6] % (by vol)
Bankard sandy loam														
0- 6	8.6	8.4	26.92	16.83	25.83	5.5	32.3	5.7	52	32	16	SL	0	0
6- 18	8.4	3.5	7.54	4.19	19.67	8.1	31.8	4.6				LS	17	8-12
18- 29	8.1	2.4	8.65	2.40	12.53	5.3	27.8	3.8				GR-S	39	25-30
29- 60	8.0	3.6	9.73	4.05	15.86	6.0	32.9	3.5				S	0	0
60-108	7.1	5.3	21.30	7.35	20.45	5.4	27.2	4.2				GRV-LS	62	45-50
108-132	7.1	7.3	27.29	19.74	20.59	4.2	27.0	6.2	63	24	13	FSL	1	<1
132-156	8.1	3.7	14.41	6.87	14.34	4.4	29.1	5.5				GRV-LS	72	55-60
Parb shaly sandy loam														
0- 5	7.7	2.8	14.74	4.68	4.89	1.6	28.5	5.8				SH-SL	36	22-25
5- 17	8.1	3.3	13.22	4.20	12.06	4.1	31.7	8.7				SH-L	42	25-30
Gilson variant gravelly loam														
0- 6	8.5	7.8	62.33	52.68	21.71	2.9	27.2	6.8	28	52	20	GR-L	33	20-23
6- 14	8.6	9.8	75.68	103.71	10.32	1.8	28.7	7.5	32	48	20	GR-L	25	15
14- 49	8.8	65.3	401.65	635.94	103.02	4.5	31.4	8.0				GR-SCL	30	15-20
49- 64	8.7	12.4	1.90	0.74	119.80	104.4	63.3	8.8				CL	14	5-10
64- 84	8.4	13.0	1.64	0.55	108.22	103.3	73.0	8.8				CL	1	<1
Shavano shaly loam														
0 - 7	8.4	4.9	17.37	14.48	14.00	3.5	29.8	8.3				SH-L	36	22-25
7 - 22	8.5	8.7	31.94	15.23	15.02	5.2	29.2	8.4	40	41	19	SH-L	39	25-30

NOTES:
(1) electrical conductivity
(2) sodium adsorption ratio
(3) saturation percentage
(4) laboratory analysis
(5) GR - gravelly; GRV - very gravelly; SH - shaly; CNV - very channery; CNX - extremely channery; L - loam; LS - loamy sand; S - sand; VFSL - very fine sandy loam; SL - sandy loam; SCL - sandy clay loam; FSL - fine sandy loam; CL - clay loam
(6) calculated assuming bulk density of 1.5 g/cc

millimhos per centimeter and SAR from 4.2 to 8.1. Textures typically are loamy sand, gravelly loamy sand, gravelly loamy sand or sand throughout most of the profile, with a sandy loam surface texture. Coarse fragment content ranges from 0 to 30 percent by volume in the upper 60 inches of the profile and from 0 to 50 percent by volume in the lower 96 inches of the profile. The saturation percentages range from 27 to 32.9 and lime percentages range from 3.5 to 6.2. At depths greater than 18 inches, coarse fragment percentages exceed levels recommended as ideal surficial soils.

The surface, 18 inches, of these soils are suitable for use as surficial soils during reclamation.

Gilson Variant - These deep, well-drained soils are on alluvial fans below the shale controlled hills. Soil pH ranges from 8.4 to 8.8, EC from 7.8 to 65.3 millimhos per centimeter and SAR from 1.8 to 104.4. Textures typically are gravelly sandy clay loam or clay loam with gravelly loam surface textures. Coarse fragment content ranges from 0 to 23 percent by volume. Lime percentages range from 6.8 to 8.8 and saturation percentages range from 27.2 to 73. The surface 14 inches of these soils generally are suitable for use during reclamation.

Shavano Series - These moderately deep, well-drained soils formed in colluvium and alluvium derived from shale and are on alluvial fan positions at the base of the shale controlled hills. Soil pH ranges from 8.4 to 8.5, EC from 4.9 to 8.7 millimhos per centimeter and the SAR ranges from 3.5 to 5.2. Soil texture typically is shaly loam with greater than 18 percent clay and 22 to 30 percent by volume, coarse fragments. Percent lime ranges from 8.3 to 8.4 and saturation percentages range from 29.2 to 29.8.

These soils are suitable for stripping to depths of 40 inches or bedrock, whichever occurs first. Because coarse fragments occur in excess of 20 percent by volume, these soils are deemed not ideally suited for surficial soils use.

Additional Soils Information was obtained from Lab Results from VTN's Field Trip in August, 1980, Paraho Module Project.

Introduction

Five soil samples were collected from Section 32 (T9S., R.25E.) at the Paraho site as an aid in determining the suitability of the existing soil as a substrate for revegetation. Sample 1 represents Walknolls soils; Samples 2 through 5 represent the Otero-Gilson mapping unit. A deep phase was sampled at 15 inches (A horizon) and 36 inches (C horizon), while the shallow phase was sampled at 12 inches (A horizon) and 24 inches (C horizon). A very shallow phase was sampled at 5 inches which was the total depth over the shale parent material.

The deep phase of this series was sampled in the northwest quarter of Section 32 in the area proposed for retorted shale disposal, and the other two phases were sampled in the SW 1/4 NW 1/4 (shallow phase) and the SW 1/4 NE 1/4 (very shallow phase) as shown in Figure 3. Representative sites were sampled. The lab analysis was performed by Agricultural Consultants, Inc., of Brighton, Colorado. Table 4 and the accompanying legend show the parameters measured, techniques used, and the results of the laboratory analysis.

Discussion

The pH of all the samples was in the range of 8-9 which is typical for arid regions and can affect nutrient availability and moisture relationships. Few of the parameters showed much variability between the samples, available potassium being the lone exception which decreased with depth. There was some tendency for cations such as Na, Mg and Ca to increase with depth as did electrical conductivity, base saturation and sodium absorption ratio. All of

TABLE 4

PARAHO SOIL LAB ANALYSIS
AUGUST 1980
(see following Legend for Units)

Sample Number*	pH	EC	Ca	Mg	Na	SAR	CEC	%BS	N	P	AK
1	8.0	2.81	15.40	2.34	7.33	2.50	8.6	100.0	3	3	220
2	8.5	2.98	29.00	8.47	8.71	2.40	9.6	100.0	2	2	90
3	8.4	3.51	25.50	11.70	11.90	2.80	9.8	100.0	2	2	30
4	8.7	4.57	44.40	16.40	20.10	3.90	9.9	100.0	3	1	30
5	8.5	4.95	28.00	7.88	14.90	3.50	9.8	100.0	1	2	32

Sample Number*	OM	SN	SI	CL	Cu	Mo	Pb	Se	Zn
1	0.1	74	25	1	0.4	-0.1	1.2	-0.01	0.6
2	0.1	79	21	0	0.7	-0.1	1.1	-0.01	0.4
3	0.1	70	30	0	0.6	-0.1	0.9	-0.01	0.3
4	0.1	72	28	0	0.5	-0.1	1.0	-0.01	0.5
5	0.1	71	29	0	0.3	-0.1	1.3	-0.01	0.3

Minus sign = less than reporting minimums

* 1 Very shallow phase A/C horizons
2. Deep phase A horizon
3. Shallow phase A horizon
4. Deep phase C horizon
5. Shallow phase C horizon

LEGEND

For Table 4

pH	Paste pH
EC	Electrical conductivity, mmhos/cc, USDA Handbook 60, Chapter 6, (4) Conductivity Electrode/Wheatstone Bridge
Ca	Calcium, meq/l, USDA Handbook 60, Chapter 6 (8)/ Quantitation by AAS
Mg	Magnesium, meq/l, USDA Handbook 60, Chapter 6 (9)/ Quantitation by AAS
Na	Sodium, meq/l, USDA Handbook 60, Chapter 6 (10A)/ Quantitation by AAS
SAR	Sodium Adsorption Ratio, USDA Handbook 60, Chapter 5 (PP72)/Quantitation by AAS
CEC	Cation Exchange Capacity, meq/100g, USDA Handbook 60, Chapter 6 (20A)/Quantitation by AAS
%BS	Base Saturation, % American Society of Agriculture #9
N	Nitrate Nitrogen, ppm, Specific Ion Electrode
P	Phosphorus, ppm, American Society of Agriculture #9
AK	Available Potassium, ppm, Amer. So. of Agr. #9
OM	Organic Matter (humus), % American Society of Agriculture #9
SN	Sandy or sand (%), USDA Diagram
SI	Silty or Silt (%), USDA Diagram
CL	Clay (%), USDA Diagram
Cu	Copper, ppm, DTPA Ext/AAS Quantitation
Mo	Molybdenum (total), ppm, Acid Digestion/AAS Quantitation
Pb	Lead, ppm, DTPA Ext/AAS Quantitiation
Se	Selenium (Soluble), ppm, DAN/Fluorimetric
Zn	Zinc, ppm, DTPA Ext/AAS Quantitation

these parameters showed high values, largely as a function of low leaching rates. Cation exchange capacity was relatively low, but given the sandy texture of these soils and a general lack of organic matter, they are adequate as a plant growth medium for the species typically used for revegetation. Nitrogen levels were very low, measured as nitrate-N, which partially reflects the low amounts of organic matter. Plant available phosphorus levels were very low also for all the samples, but this element is less likely than nitrogen to be a limiting factor in revegetation efforts. The samples averaged about 75 percent sand and 25 percent silt with only a trace of clay. This will primarily limit moisture retention and cation exchange capacity. Copper levels were deficient as were zinc levels which are restricted by high pH levels. Molybdenum levels were also deficient. Lead levels were low and not judged to pose a hazard as it is not required by plants. Selenium levels were very low, which was surprising, as a few plant species, notably those of the genus *Astragalus*, are common at the site. These are known to accumulate selenium and may result in toxic effects on grazing animals if consumed in significant quantities.

The soils examined in this analysis strongly reflect the arid environment of their formation, their young age and the nature of the area's sandstone parent material. The basic cations are prevalent as free cations and salts. Exchange sites are not prevalent because of the high proportion of sand. These soils are low in nitrogen with a limited ability to hold water for plant growth. They are shallow and tend to have many rock fragments which further decreases the effective soil depth. Along with low, naturally occurring precipitation, these soils now support only a low density, xeric plant community.

Paragraph 4

Soil Protection

The topsoil stockpiles will be protected by the use of drainage diversions, including any structures necessary to minimize erosion. All drainage will be diverted away from the piles. Berms will be used where necessary. The piles will be riprapped on the downslope side only; the other exposed sides will be seeded and mulched with a cover crop which will include legumes, such as alfalfa to enhance nitrogen content, and obligate mycorrhizal symbionts, such as Poa or Bouteloua species, to ensure long-term viability of the microorganisms.

Paragraph 5

The piles will be developed in vertical segments so that once established, only the working front of the pile will be disturbed until its configuration is completed. This approach to pile development will best minimize pile disturbance for the establishment of vegetation while still allowing materials to be added.

The soil stockpile in the NE corner of Section 32 would remain static during operation of the plant. The stockpile in the SW corner of Section 32 would increase in volume with the development of the raw shale fines storage area and the stockpile in the SW corner of Section 6 would increase in volume with the development of the retorted shale disposal area.

A cross section of each soil stockpile, retorted shale pile, and raw shale pile are shown in Figures 8 - 10. Figures 6 and 7 show the locations of the cross sections. Line A-A' refers to the raw shale fines; B-B' refers to the surficial soils pile, southwest, Section 32; C-C' refers to the surficial soils pile, northeast, Section 32; D-D' refers to the retorted shale pile; and E-E' refers to the surficial soils pile, west, Section 6. The cross-sections are further discussed under M-10(4). Figure 11 shows an approximate polyhedron of a soil storage pile.

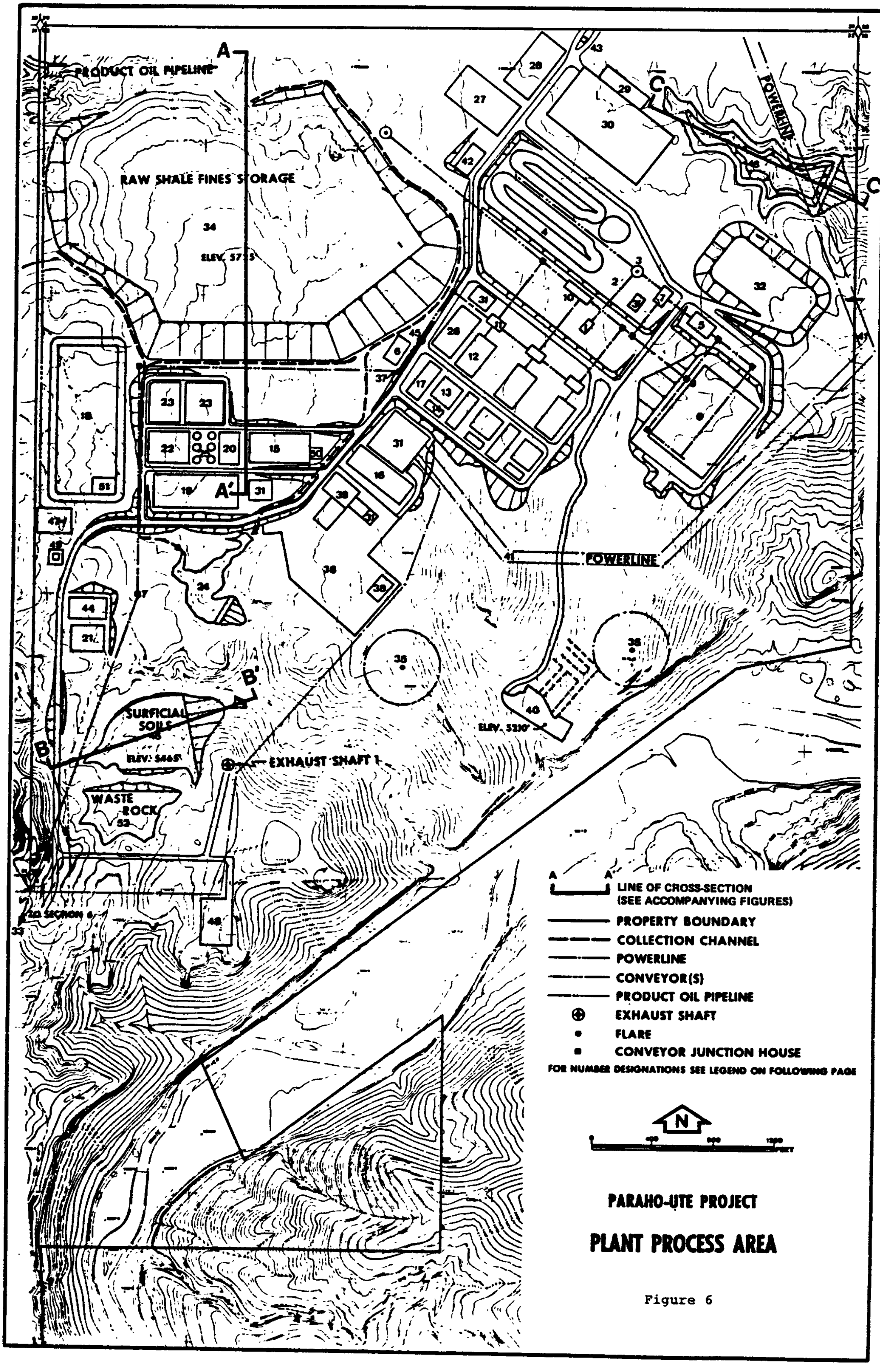
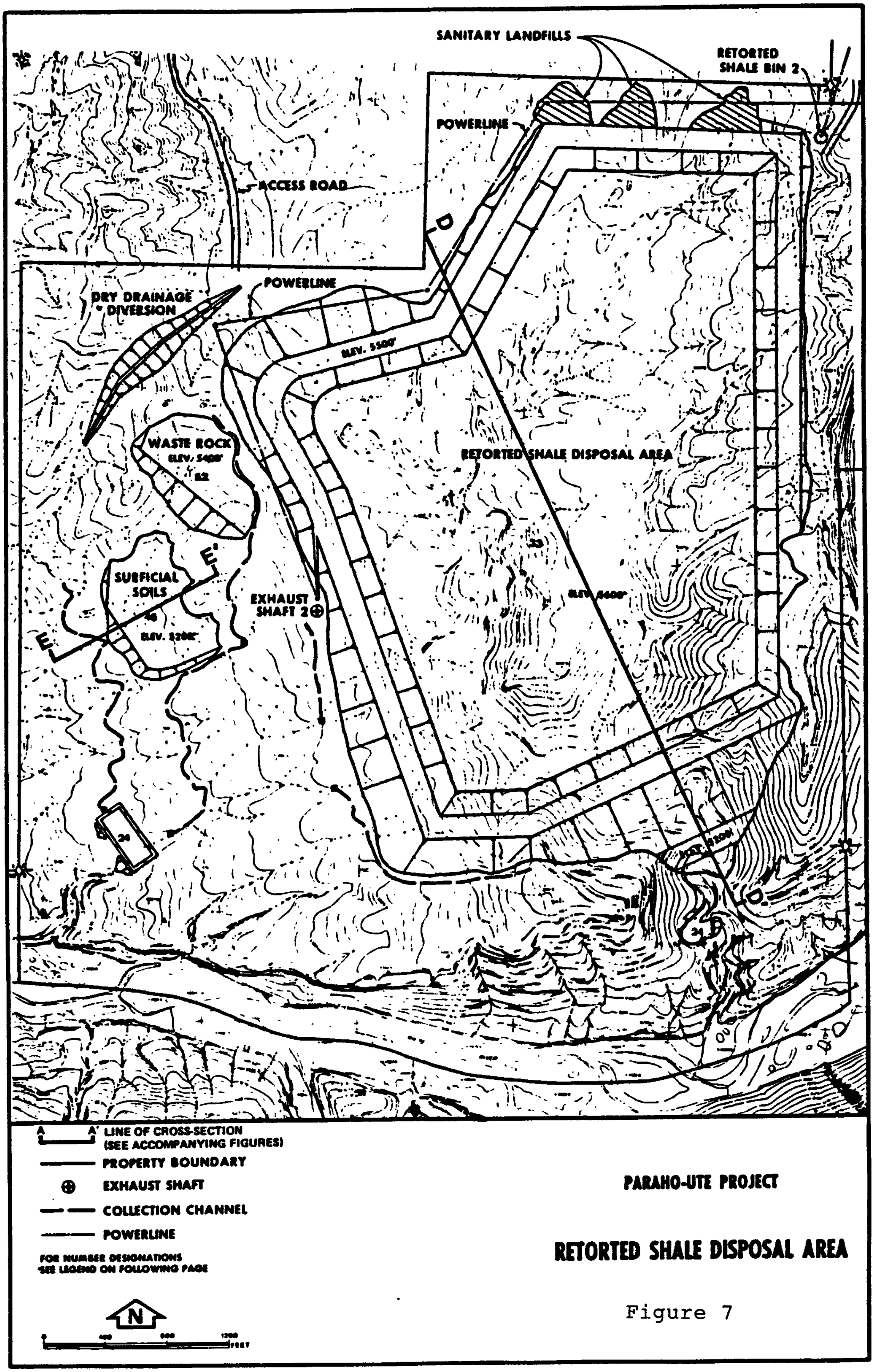

PRODUCT OIL PIPELINE
RAW SHALE FINES STORAGE
ELEV. 5725'
POWERLINE
SURFICIAL SOILS
ELEV. 5465'
EXHAUST SHAFT 1
WASTE ROCK
ELEV. 5210'
LINE OF CROSS-SECTION (SEE ACCOMPANYING FIGURES)
PROPERTY BOUNDARY
COLLECTION CHANNEL
POWERLINE
CONVEYOR(S)
PRODUCT OIL PIPELINE
EXHAUST SHAFT
FLARE
CONVEYOR JUNCTION HOUSE
FOR NUMBER DESIGNATIONS SEE LEGEND ON FOLLOWING PAGE
N
PARAHO-UTE PROJECT
PLANT PROCESS AREA

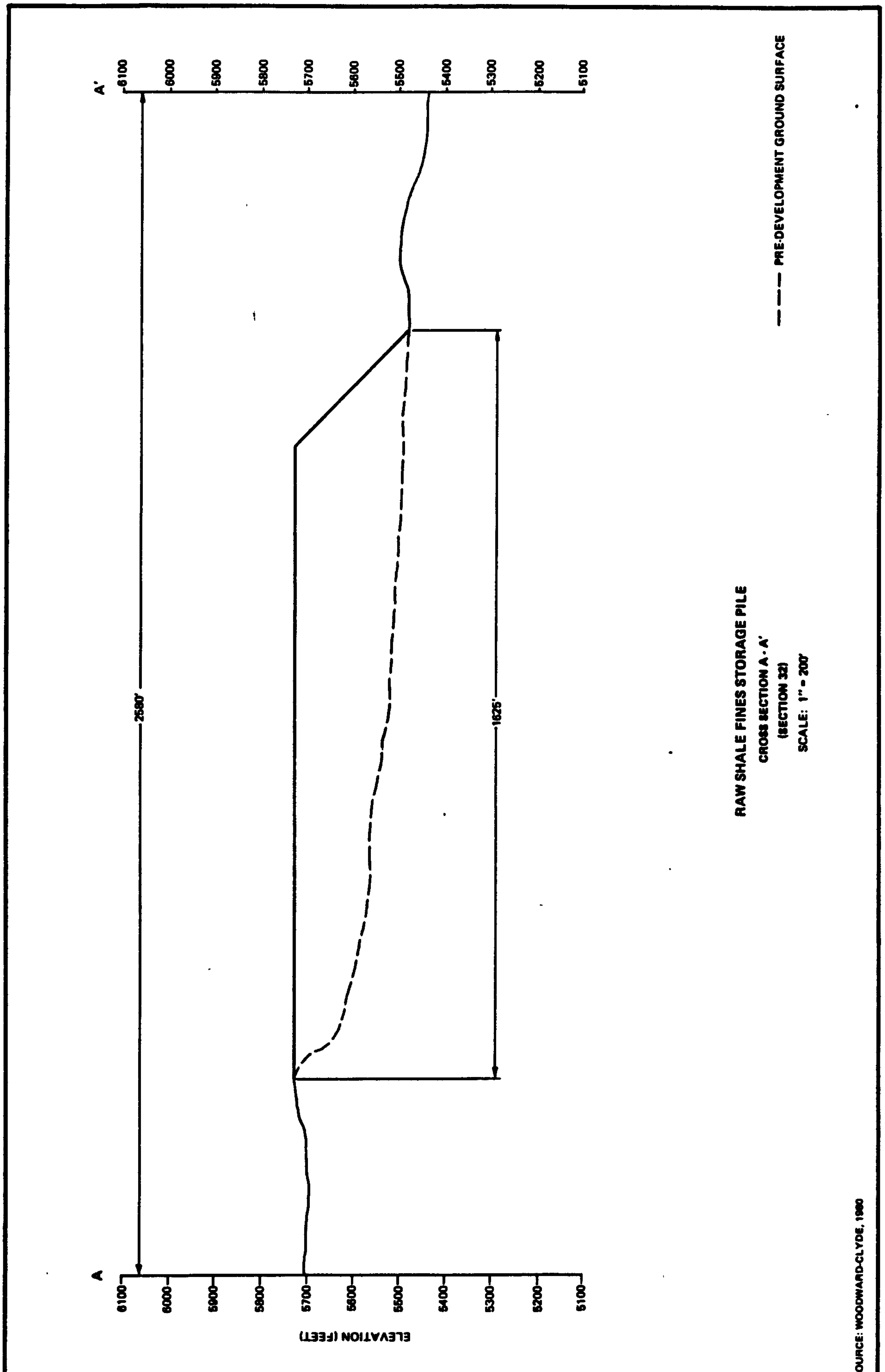
Figure 6



PARAHO-UTE PROJECT

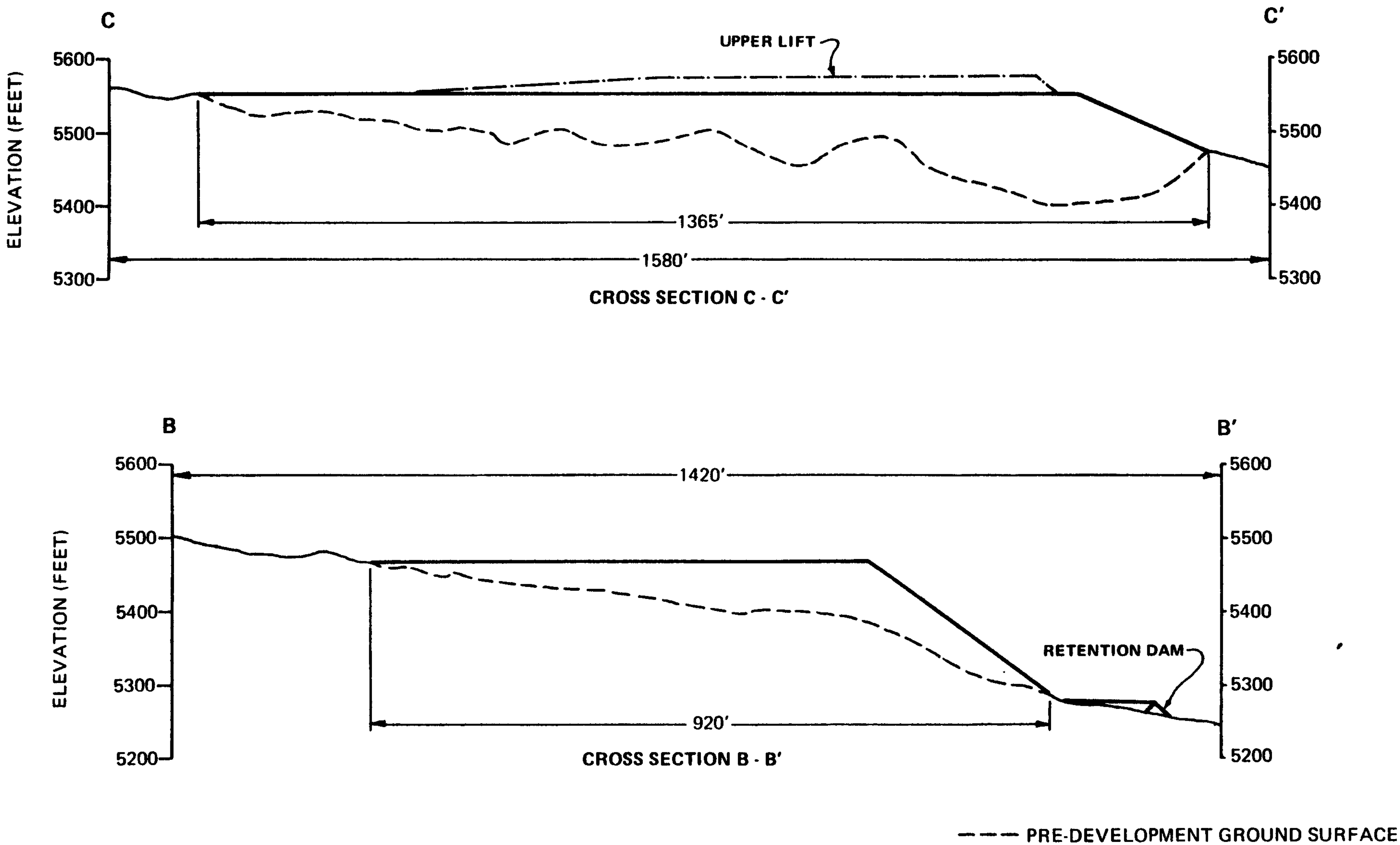
RETORTED SHALE DISPOSAL AREA

Figure 7



RAW SHALE FINES STORAGE PILE
CROSS SECTION A - A'
(SECTION 32)
SCALE: 1" = 200'

Figure 8

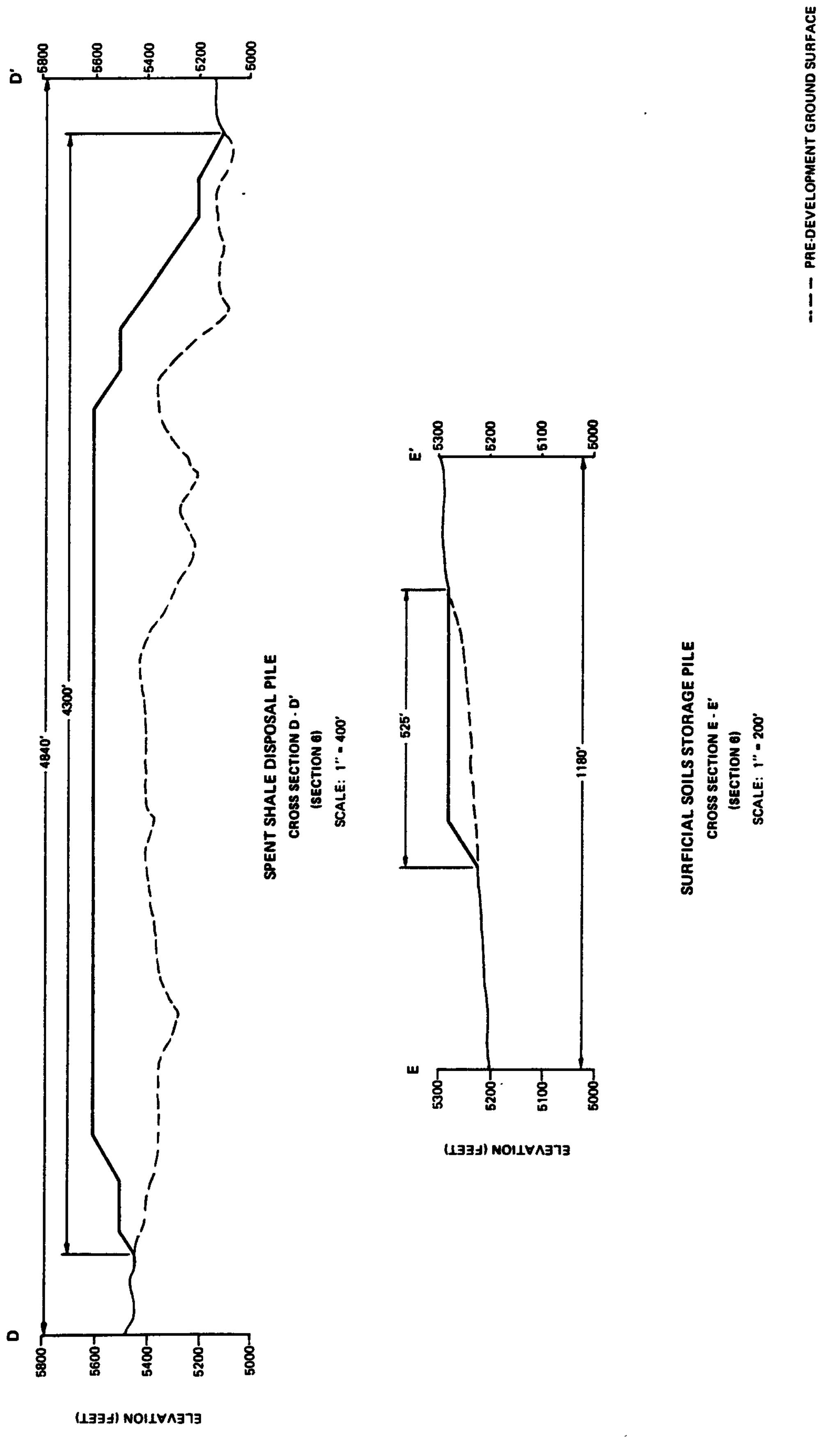


SURFICIAL SOILS STORAGE PILES

(SECTION 32)

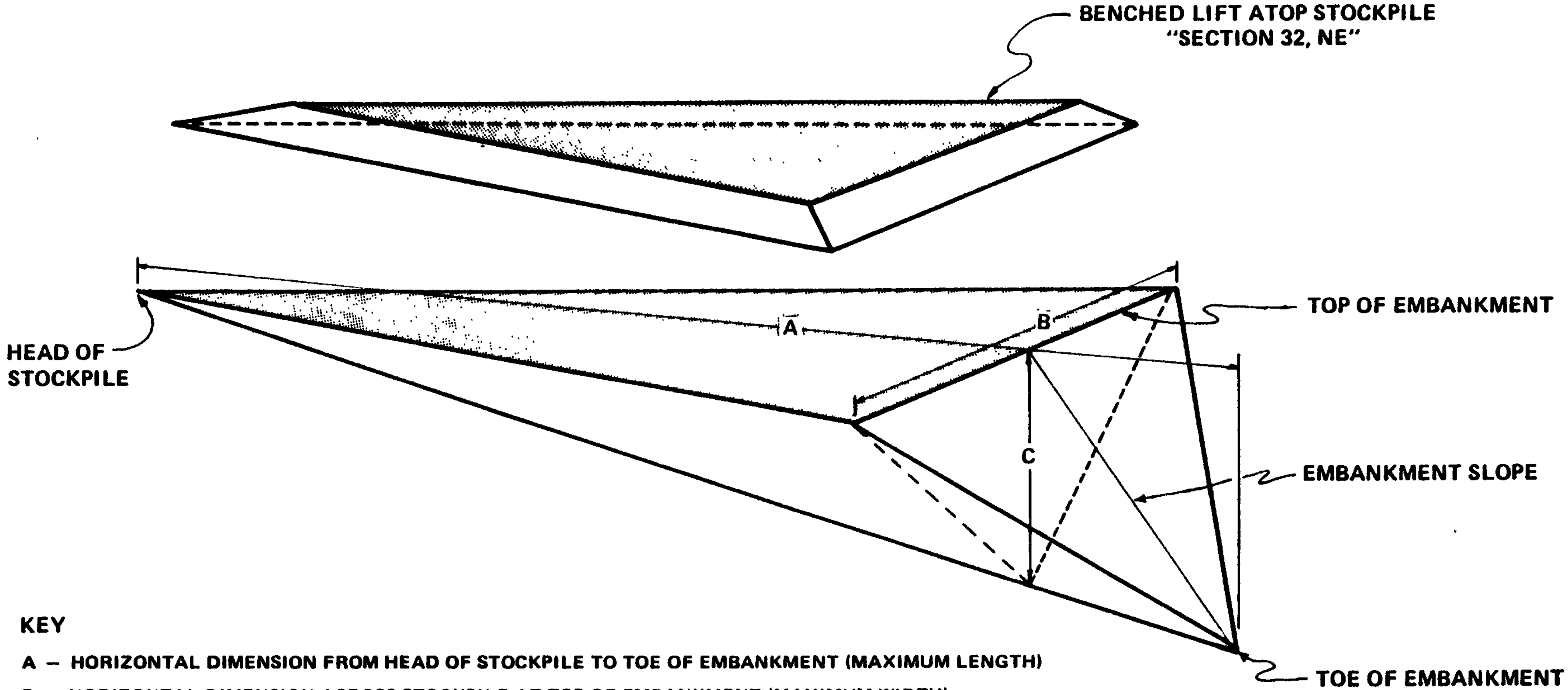
SCALE: 1" = 200'

Figure 9



SPENT SHALE DISPOSAL PILE
CROSS SECTION D - D'
(SECTION 6)
SCALE: 1" = 400'
D
D'
4840'
4300'
ELEVATION (FEET)
5800
5600
5400
5200
5000
SURFICIAL SOILS STORAGE PILE
CROSS SECTION E - E'
(SECTION 6)
SCALE: 1" = 200'
E
E'
525'
1180'
5300
5200
5100
5000
PRE-DEVELOPMENT GROUND SURFACE

Figure 10



KEY

A – HORIZONTAL DIMENSION FROM HEAD OF STOCKPILE TO TOE OF EMBANKMENT (MAXIMUM LENGTH)

B – HORIZONTAL DIMENSION ACROSS STOCKPILE AT TOP OF EMBANKMENT (MAXIMUM WIDTH)

C – VERTICAL DIMENSION FROM TOP OF EMBANKMENT TO BASE OF STOCKPILE (MAXIMUM THICKNESS)

APPROXIMATE SOILS STORAGE PILE POLYHEDRON

FIGURE 11

Paraho

Rule 3(1) (e) (g)

There are three surficial soils stockpile sites and one waste rock stockpile planned. The utilization of the surface plot plan Drawing 8103-GY-Gl and the site preparation plan Drawing 5589-E-0163-SK-9 together will provide the locations of the four stockpile sites. Updated plot plans are found as Figures 6 and 7.

Rip-rap will be placed on the steep face of surficial soils stockpiles. The top of the stockpiles will be relatively flat and revegetated until needed for reclamation procedures. No segregation of rip-rap and surficial soils is planned.

Soil Redistribution

The use of a capillary barrier as mitigation for upward movement of salts will be researched in the test plot. If revegetation is successful without a capillary barrier, then it will not be included in the final revegetation program.

A soil tabulation chart (Table 5) for the Paraho Development site has been completed. The chart tabulates soils by area disturbed. Three major reclamation sites were considered: the retorted shale disposal pile, the raw shale fines piles, and project facilities. The last category contains all surface facilities, roads and pipelines. Since these lie primarily in Section 32 and are mostly contiguous, it was decided to treat them as a unit. Table 5 continues for three additional pages to demonstrate the estimated growth and usage of materials for the three principal soils storage areas (shown as B-B', C-C', and E-E' in Figures 6 and 7). Finally, Table 5 continues for two more additional pages to include the calculations associated with the removal and replacement of surficial soils from the retorted shale disposal pile, the raw shale fines, and roads, facilities and ROW's.

In determining the depth of removal for the retorted shale disposal pile, acreage of each soil mapping unit was determined. Average depths used were based on Soil Conservation Service Data

TABLE 5

SOIL TABULATION CHART

Area in Question	Retorted Shale Disposal Pile	Raw Shale Fines	Facilities, Roads, ROWs
Soil Type	Walknolls; Otero-Gilson; BA-WA-Ro	Walknolls	Walknolls
Acreage of Area	235 + 20 + 85 = 340 ac.	70	294
Depth of Removal	6 to 18 inches	18 inches	18 inches
Depth of Replacement	12 inches	12 inches	12 inches
Vol. Rquired for Reclamation	548,533 cu. yd.	112,933 cu. yd	474,320 cu. yd.
Est. Vol. to be Salvaged	669,534 cu. yd	169,399 cu. yd.	711,480 cu. yd.
Vol. Actually Salvaged	--	--	--
Surplus or Deficit Volume	121,000 cu. yd.	46,466 cu. yd	237,160 cu. yd.
Storage Status			
Storage Location	Section 6, SW Corner, Section 32, NE & SW Corners	Section 32, NE corner	Section 32, NE corners
Running Total Short-Term Long-Term	Following Pages of Table 5		
Total Salvage Vol. (Σ line 6)	1,550,413 cu. yd.		
Total Reqd. Vol. (Σ line 5)	1,135,786 cu. yd.		

TABLE 5

SOILS TABULATION CHART (continued)

SOILS STOCKPILES - Running Totals

Facilities, Road, ROW's

Fines and Retorted Shale Areas

(Stockpile - NE Corner, Section 32)

Year	Surficial Soils (yds)	Input/Output Total Yds
1983	180,000	180,000
1984	430,000	610,000
1985	110,000	720,000
1986	80,000	800,000
1987	120,000	920,000
1988	130,000	1,050,000
1989-1984	---	1,050,000
TOTAL	1050,000	1,050,000
Post-Op, 1st-2nd yr		1,050,000
3rd yr	550,000	500,000
4th yr	260,000	240,000
5th yr	240,000	---

TABLE 5

Soils Tabulation Chart (continued)

SOILS STOCKPILES - RUNNING TOTALS

Stockpile - SW Corner, Section 6

Retorted Shale Disposal Area

Year	Surficial Soils Annual (Yds)	Input/Output Total (Yds)
1985	125,000	125,000
1986	115,000	240,000
1987-1994	---	240,000
TOTAL	240,000	240,000
Post-Op, 1st yr	-240,000	---
Post-Op, 2nd yr	---	---

TABLE 5

SOILS TABULATION CHART (continued)

SOILS STOCKPILES - RUNNING TOTALS

Stockpile - SW Corner, Section 32

Retorted Shale Disposal Area

Year	Surficial Soils Input Annual (Yds)	Input/Output Total (Yds)
1989	110,000	110,000
1990	100,000	210,000
1991	50,000	260,000
1991-1994	260,000	260,000
TOTAL	260,000	260,000
Post-Op, 1st yr	-140,000	120,000
Post-Op, 2nd yr	-120,000	---
Post-Op, 3rd yr	---	---

NOTE: Figures are rounded to nearest thousand cubic yards.

TABLE 5
SOIL TABULATION CHART (continued)
CACULATIONS

Retorted Shale Disposal Pile

1. Walknolls
18 inches removed; 12 inches replaced

$$(43{,}560\ \frac{\text{sq ft}}{\text{ac}})\ (235\ \text{ac})\ (1.5\ \text{ft dept})\ (\frac{1\ \text{cu yd}}{27\ \text{sq ft}}) = 568{,}700\ \text{cu yd removed}$$

$$(43{,}560\ \frac{\text{sq ft}}{\text{ac}})\ (235\ \text{ac})\ (\frac{1\ \text{cu yd}}{27\ \text{sq ft}}) = 379{,}133\ \text{cu yd replaced}$$

2. Otero-Gilson

12 inches removed; 12 inches replaced

$$(43{,}560\ \frac{\text{sq ft}}{\text{ac}})\ (20\ \text{ac})\ (\frac{1\ \text{cu yd}}{27\ \text{sq ft}}) = 32{,}267\ \text{cu yd removed and replaced}$$

3. Badlands; Walknolls; Rock Outcrop Complex

6 inches removed; 12 inches replaced

$$(43{,}560\ \frac{\text{sq ft}}{\text{ac}})\ (85\ \text{ac})\ (\frac{1\ \text{cu yd}}{27\ \text{sq ft}})\ (.5\ \text{ft deep}) = 68{,}567\ \text{cu yd removed}$$

$$(43{,}560\ \frac{\text{sq ft}}{\text{ac}})\ (85\ \text{ac})\ (\frac{1\ \text{cu yd}}{27\ \text{sq ft}}) = 137{,}133\ \text{cu yd replaced}$$

TOTALS 1, 2, and 3: 669,534 cu yds removed; 548,533 cu yds replaced

TABLE 5
Soil Tabulation Chart (continued)
RAW SHALE FINES

CALCULATIONS

Raw Shale Fines

18 inches of soil will be removed; 12 inches will be replaced.

$$(43{,}560\ \frac{\text{ac ft}}{\text{cu ft}})\ (70\text{ ac})\ (1.5\text{ ft deep}) = 4{,}573{,}900\text{ cu ft}$$

$$4{,}573{,}800\text{ cu ft} \times \frac{1\text{ cu yd}}{27\text{ cu ft}} = 169{,}400\text{ cu yd removed}$$

$$(43{,}560\ \frac{\text{ac ft}}{\text{cu ft}})\ (70\text{ac})\ (\frac{1\text{ cu yd}}{27\text{ cu ft}}) = 112{,}933\text{ cu yd replaced}$$

Facilities Roads, Pipelines & ROW's

18 inches of soil will be removed; 12 inches will be replaced.

$$(43{,}560\ \frac{\text{sq ft}}{\text{ac}})\ (294\text{ ac})\ (1.5\text{ ft deep})\ (\frac{1\text{ cu yd}}{27\text{ sq ft}}) = 711{,}480\text{ cu yd removed}$$

$$(43{,}560\ \frac{\text{sq ft}}{\text{ac}})\ (294\text{ ac})\ (\frac{1\text{ cu yd}}{27\text{ sq ft}}) = 474{,}320\text{ cu yd replaced}$$

for modal pedon depth. Extensive field data on soil depths is not currently available. Thus, the figures presented should be viewed as approximations of soil depths and quantities on the project site.

The estimated depth of walknolls series averages 18 inches, but a minimum of 12 inches will be replaced on a disturbed area for revegetation. In determining topsoil depths for the retorted shale disposal pile, it was decided to use a minimum replacement depth of 12 inches, rather than try to duplicate the pre-existing soil depths.

Given the approximate nature of the data, and being very conservative in utiliziation of topsoil, it appears that there is adequate material available to successfully reclaim and revegetate the project site. Three different soils mapping units have been identified in that area, with different average depths. Since post-mining topography wil be significantly altered from that found at present, it seems most reasonable to use a single depth for post-mining reclamation, as the surface of the shale pile will be a uniform, slightly sloping plateau.

The soils stripped from each of the three areas will be placed in stockpiles as follows:

- Soils from retorted shale disposal area will be placed in soil storage area in the southwest corner of Section 6, southwest corner of Section 32, and northeast corner of Section 32.

- Soils from the raw shale fines disposal area will be placed in the stockpile in the northeast corner of Section 32.

- Soils from the project facilities roads and right-of-way will be placed in the storage pile in the northeast corner of Section 32.

Rule M-10(14) M-3(1)(f) (continued)

Paragraph 5

The bulk density of surrounding soil and replaced soil will be determined at the time of reclamation. Compaction of soils will be tested to determine methods required to achieve baseline bulk density using a test such as the standard compaction test ASTM - 698. These methods will be followed, achieving the approximate baseline bulk density.

Fall is the preferred time of seedbed preparation and seeding. Throughout operations, small areas may be reclaimed according to needs, with supplemental revegetating as needed for successful reclamation. The final reclamation of the project site will be planned for the fall season.

Rule M-3(2)(c), M-10(6)

All suitable waste rock will be used as rip-rap. Rip-rap facing of the retorted shale disposal slopes represents a permanent use to assure long-term stability, rip-rap in other areas, such as the exposed slopes of dams and soil storage, would be used only as long as protection for those slopes is needed. Most of the rock used as rip-rap will originate from construction of the diversion cut on Section 6 and other surface cuts as needed. This surface rock should not contain any of the saline, alkaline minerals that may be found near the mining zone. Thus, the use of this waste rock as rip-rap should not pose any serious problems with salinity or alkalinity from run-off. Before these rocks are used as rip-rap, results from the Environmental Monitoring Plan would indicate pH and EC values of any leachates present. Should rip-rapping prove to be unsuitable, or should there be insufficient rip-rap for adequate long-term protection of the exposed slopes, cement stabilization (see response to Rule M-10(4) would be considered.

For the most part, the waste rock obtained from development of the mine in creating adits and shafts will be small sized and unsuitable as rip-rap. This waste rock would be used primarily in upgrading roads and constructing a bench at the mine portal area.

Rule M-10(12)

Paragraph 1

Reclamation of the retorted shale benches will be started as the construction of them is completed. By the time the retorted shale pile benches are constructed, the results from the test plot plan will be available for determining reclamation procedures of the benches (see Drawing TD-Gl of the Reclamation Plan, Attachment B, Retorted Shale Pile Development).

Paragraph 2

A sprinkler irrigation system was chosen so that large areas could easily be watered. This would increase seed germination. A trickle system would not cover large areas nor increase seed germination. Although a trickle system would increase the water efficiency, a sprinkler system is more economical for short term irrigation needs.

Hydrology

Rule M-3(1)(e)

Conceptual plans have been developed to control runnoff from areas within and adjacent to the proposed processing facilities. Although final designs are not available at this time, they will be based on a good engineering practices meeting the specifications of the Utah State Engineer. Included in this section are: maps showing location of collection channels, emergency spillways, berms or culverts, drainage flow direction, and areas drained by sewers; details of runoff control in Section 32 and Section 6; and design calculations and criteria of runoff control channels.

Runoff from the plant facilities are in Section 32 will be routed through a subsurface storm sewerage system in general form on Figure 12. The various surface channels which will be installed to control runoff in the landfill area of Section 6 and the soils stockpiles and mine access road areas of Section 32 are presented in Figure 13.

Runoff Control in Section 32. Runoff controls are located around the two surficial soils storage piles, the waste rock pile, the raw shale fines storage area, and plant process area (Figure 12). The soil storage pile in the northeast corner of Section 32 has control berms and culverts around the edges of the pile to direct surface runon and runoff down through the natural drainage below the pile.

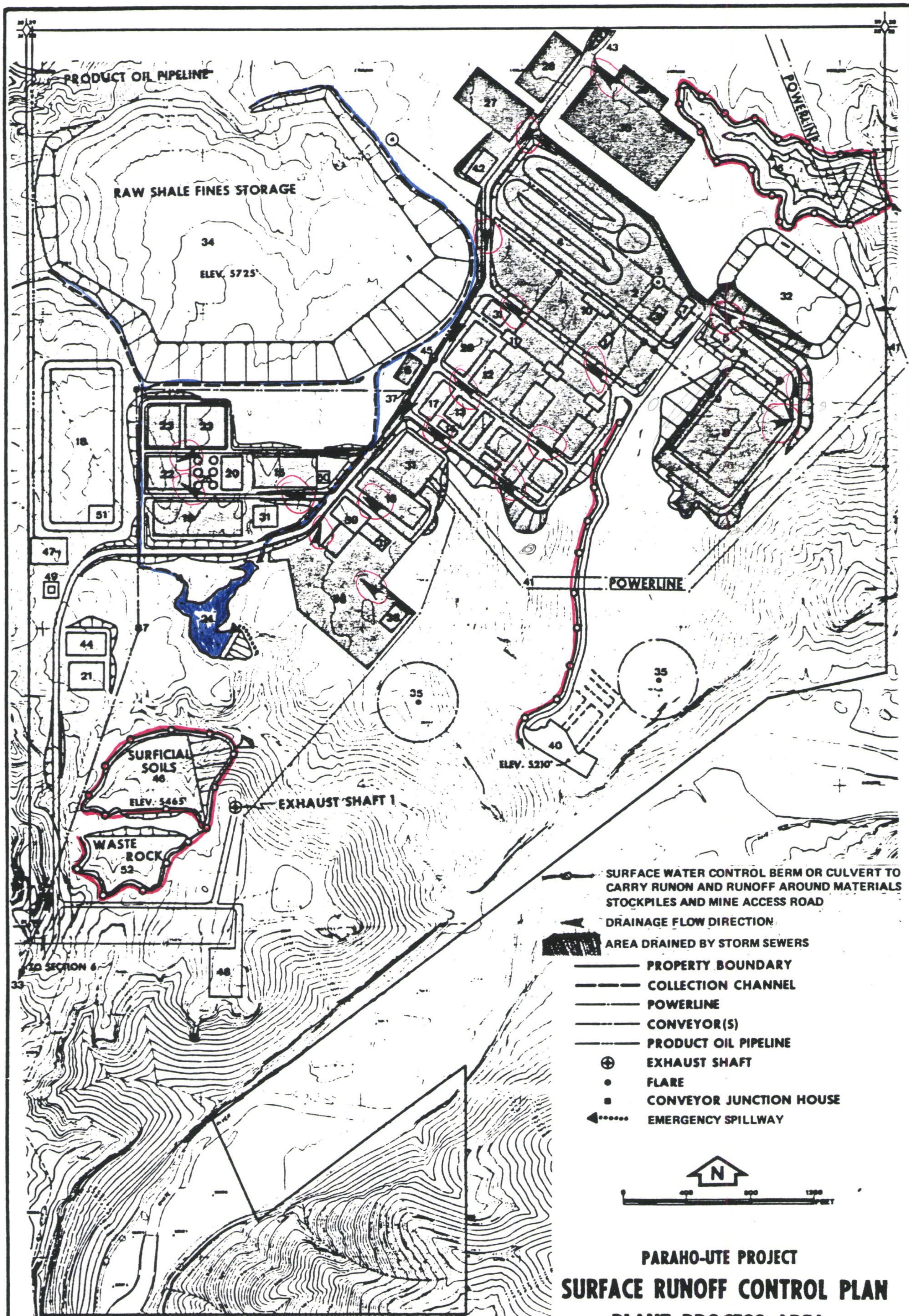
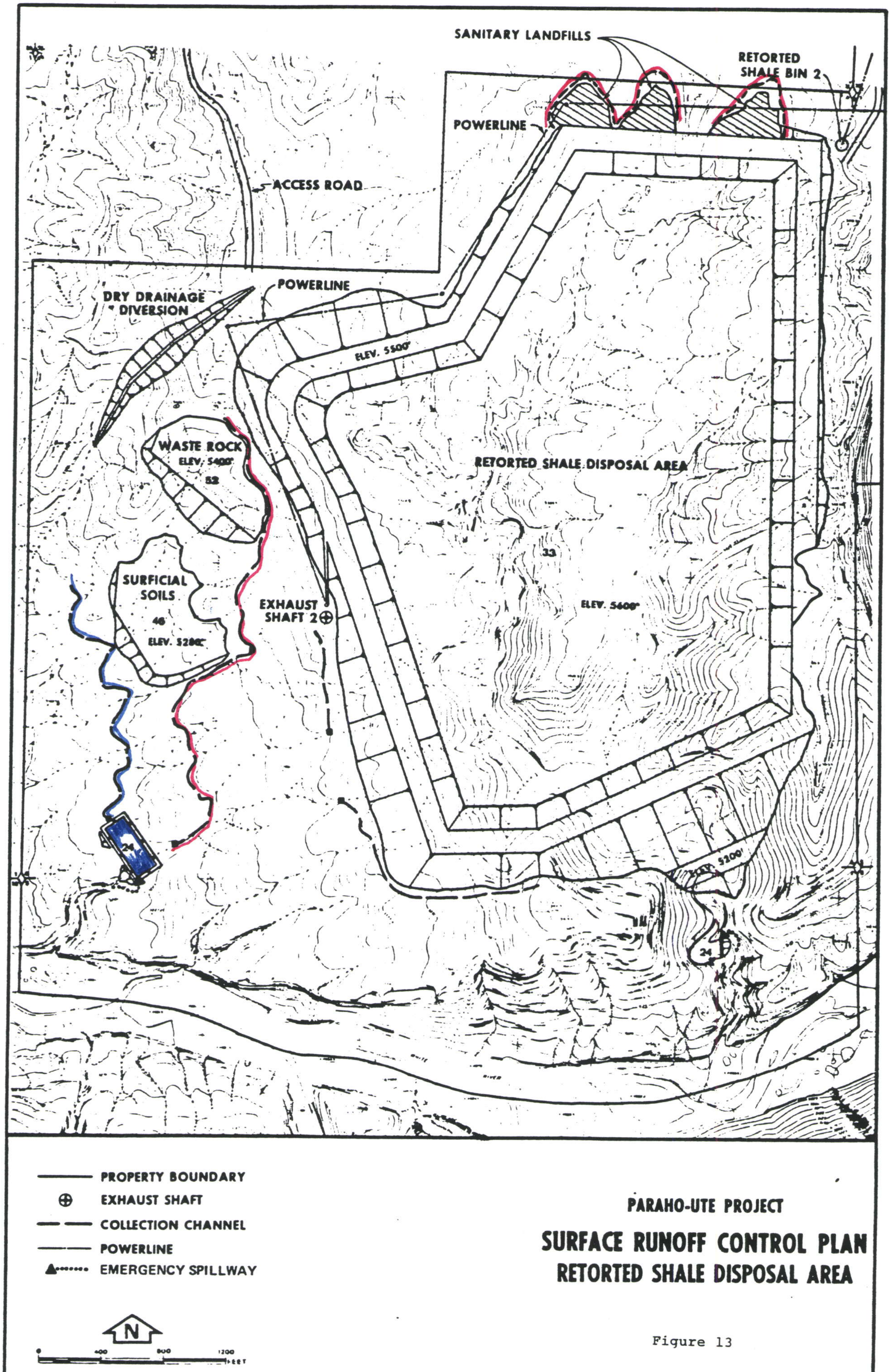

PRODUCT OIL PIPELINE
RAW SHALE FINES STORAGE
34
ELEV. 5725'
POWERLINE
SURFICIAL SOILS
46
ELEV. 5465'
WASTE ROCK
52
EXHAUST SHAFT 1
ELEV. 5210'
SURFACE WATER CONTROL BERM OR CULVERT TO CARRY RUNON AND RUNOFF AROUND MATERIALS STOCKPILES AND MINE ACCESS ROAD
DRAINAGE FLOW DIRECTION
AREA DRAINED BY STORM SEWERS
PROPERTY BOUNDARY
COLLECTION CHANNEL
POWERLINE
CONVEYOR(S)
PRODUCT OIL PIPELINE
EXHAUST SHAFT
FLARE
CONVEYOR JUNCTION HOUSE
EMERGENCY SPILLWAY
N
PARAHO-UTE PROJECT
SURFACE RUNOFF CONTROL PLAN
PLANT PROCESS AREA

Figure 12



PARAHO-UTE PROJECT

SURFACE RUNOFF CONTROL PLAN
RETORTED SHALE DISPOSAL AREA

Figure 13

Even though only a very minor amount of runoff is expected to enter the sanitary landfills (due to very small [10-acre] upstream drainage area), they will be protected to avoid washout of wastes (Figure 13).

During early landfill development, temporary unlined berms, shales or narrow benches will be excavated into the hillsides adjacent to and upstream of the first active fill area or landfill element. Additional similar control channels will be excavated above the initial channels as the landfill elevation is increased by filling. When final landfill elevation is reached, channelling and filling will then proceed in the next landfill element in a similar manner.

All runon and runoff collected during and subsequent to filling operations will be diverted and released to existing natural channels. When filling in the retorted shale pile approaches the area of the landfills, landfill area runoff may be routed through an open culvert or channelized curbing paralleling the Section 6 haul road. The haul road will be near the southern boundary of the landfill area.

The surficial soils pile and waste rock pile will be protected from runon by collection channels as shown in Figure 13. The collection channels will also direct runoff into the collection retention pond downstream of the piles. This pond is also designed to contain the runoff from a 100-year, 24 hour

The surficial soils pile and waste rock pile in the southwest corner of the section have surface water control berms and culverts around them to direct all runon and runoff to the natural drainage below the piles.

All surface water runon and runoff of the plant process area is drained through the storm sewer system to the retention pond before being processed through the waste water treatment system.

A collection channel is located all the way around the raw shale storage pile to direct the surface runoff to the retention pond for waste water treatment. Since the raw shale fines pile is located in a natural depression, very little surface runon will occur on the pile.

The sedimentation pond downstream of the southwest soils pile and the retention pond (number 24 on Figure 12) are designed to contain the runoff from a 100-year, 24 hour storm. Emergency apillways are provided in the event of a larger rainfall event. The locations of the spillways are shown on Figure 12.

Runoff Control in Section 6. Surface water runon and runoff is controlled around the sanitary landfills, surficial soils storage pile, and waste rock storage pile (Figure 13).

an emergency spillway is provided in the event of a larger rainfall event (Figure 13).

A typical cross section of a collection channel is shown in Figure 14.

<u>Design Calculations</u>. Design calculations for sizing the various surface runoff control channels shown on Figures 12 and 13 and Table 6 are based on the Handbook of Hydraulics, 6th edition (Brater and King 1976). The basic formula for trapezoidal channels is:

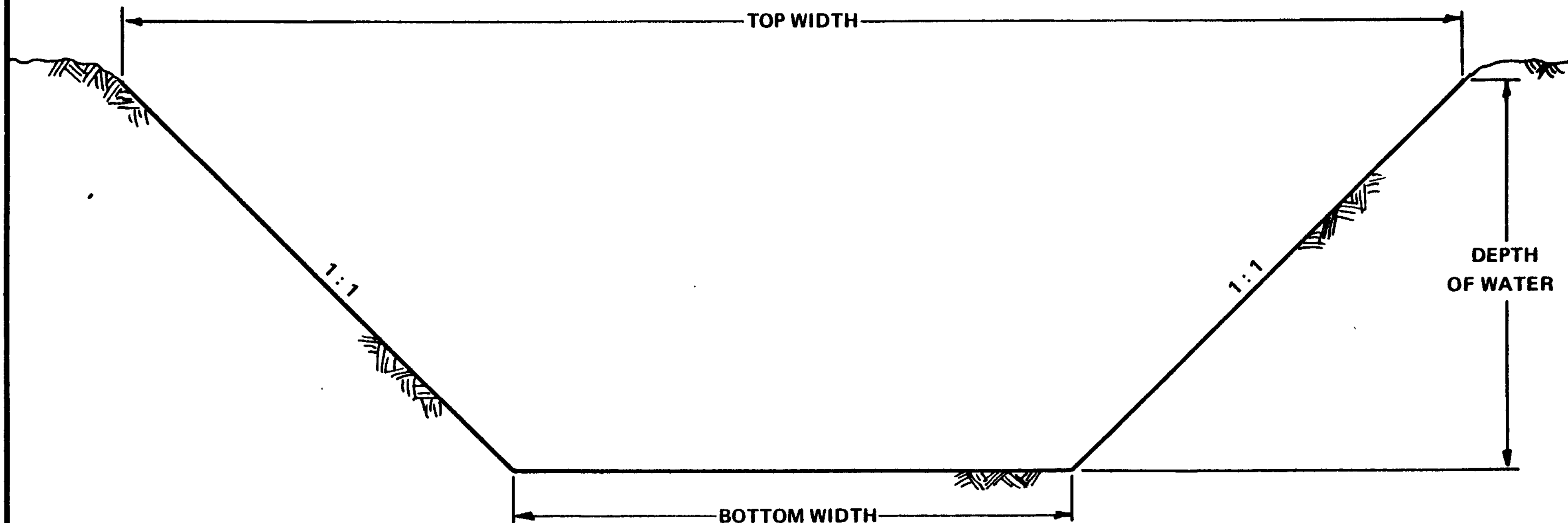
$$Q = \frac{K}{n} \times D^{8/3} \times S^{1/2} \text{ where}$$

Q = stream discharge (rational method: rainfall intensity x runoff coefficient x drainage area)

K = conveyance

n = channel depth

S = channel slope



TYPICAL CROSS SECTION

RUNOFF CONTROL CHANNEL

Figure 14

TABLE 6

DESIGN CRITERIA FOR SURFACE RUNOFF CONTROL CHANNELS
(Trapezoidal Design with 1:1 Sidewalls)

Channel	Drainage Area (ac)	Maximum Flow (cfs)	Slope (ft/ft)	Bottom Width (ft)	Top Width (ft)	Water Depth (ft)
Mine Access Road (Section 32)	40	30	0.12	2.	3.48	0.74
Soils Stockpile Section 32 NE						
(north side)	40	33	0.03	2.	4.20	1.10
(south side)	20	16	0.03	2.	3.48	0.74
Soils Stockpile (Section 32 SW)	30	25	0.075	2.	3.44	0.72
Waste Rock Stockpile (Section 32)	20	16	0.075	2.	3.12	0.56
Landfill Areas (Section 6)	10	8	0.03	0.	1.04	0.27

Rule M-3(1)(h)

Paragraph 1

Paraho plans a no wastewater discharge facility. All water produced in plant and mine operations will be treated for re-use. The diversion cut planned for Section 6, northwest of the retorted shale pile is described in Paraho's NPDES permit application as an uncontaminated runoff discharge. Further information of the wastewater treatment facilities is found in Paraho's National Pollutant Discharge Elimination System permit application (L. K. Limbach: D. W. Hedberg, September 30, 1982).

Paragraph 2

Paraho does not plan to develop any wells to obtain water from the Birdsnest aquifer or any other aquifer. All early drilling operations show insufficient water for productive well operations.

Paragraph 3

The water source for mine development and operation will be the White River. Quantities of water to be used in mining operations are found in the Mining Plan, Attachment A of the permit application (p. 73-74). Potable water for the mine service building and underground facilities will be processed above ground through the potable water treatment plant. Waste water from the mine service building and underground service facility will be collected and treated in the sewage treatment plant. From the sewage treatment plant, this water will be transferred to the retention pond on Section 32 for re-use as dust suppressant. The anticipated quality of the retention pond water is as follows:

Parameter	
Biochemical Oxygen Demand (5-day)	63 mg/l
Chemical Oxygen Demand	1,000 mg/l
Total Suspended Solids	95 mg/l
Ammonia	44 mg/l
pH	6.5-8.0

Paragraph 4

Paraho operations are not expected to impact the alluvial wells owned by American Gilsonite. The water that Paraho plans takes from the White River will not significantly affect the river flow nor is Paraho's water intake located near the American Gilsonite wells. Paraho will not use the system that America Gisonite is using.

Paragraph 5

The information gathered from surface drilling indicates that minimal water will be encountered at the Birdsnest zone for the shafts or conveyor incline. At the time of construction, the incline and shafts will be lined with concrete which should be adequate to seal the shafts and incline.

Response to Rule M-10(2)(b)(6)

Paragraph 1 & 2

The term solid waste means non-hazardous solid wastes. Paraho will operate three separate and distinct disposal areas on the project site. The main disposal area will consist of a retorted shale pile used primarily for the disposal of retort process waste rock, but which will also receive a small proportion of other non-hazardous process wastes and municipal or domestic type solid wastes. The second disposal area will be a small sanitary landfill near the retorted shale pile. The sanitary landfill will be used for the disposal of construction debris and municipal-type solid waste (MSW) generated during initial project development, while the retorted shale area is being prepared to receive wastes. The third area will be the storage of raw shale fines.

Several non-hazardous, non-reclaimable solid wastes will be disposed of in the retorted shale pile. These include waste-water treatment and water pre-treatment lime sludges, sulfur cake, garbage and scrap. These wastes will be deposited in the pile and covered daily with retorted shale (Table 7).

Specific waste types and estimated maximum quantities to be placed in the sanitary landfill are summarized in Table 8. Estimates are based on prior experience and projections by the construction camp and plant construction building contractors. A high or conservative quantity has been assigned to some

TABLE 7

SOLID WASTE QUANTITIES AND DISPOSITION

Method of Disposal	Solid Waste	Quantity & Design Case Rates
A. On-site Landfill	Construction Debris and Garbage	16,000 cu yd (first 3 years)
B. Raw Shale Fines Storate (Temporary)	Raw Shale Fines	7,385 T/D (max)
C. Retorted Shale Disposal Area	Retorted Shale Waste-Water Treatment Sludge	53,235 T/D, 2,486 T/D (wet basis, 0.6% solids)
	Sulfur, Crystalline	95 T/D
	Scrap and Garbage	4.6 T/D
D. Other		
Reclamation	Oil Filter Particles	64 T/D (50% oil)
	ZnO Catalyst	250 cu ft/6 mo
	Lo-Temp CO Shift Catalyst	2,600 cu ft/2 yr
	Methanator Catalyst	600 cu ft/2 yr
	Reformer Catalyst	1,500 cu ft/2 yr
	Hydrotreater Catalyst (ICR-106)	(Confidential)
Off-Site Hazardous Waste	API Separator Bottoms	0.9 T/D
	Air Flotation Unit Float	0.09 T/D
	High-Temp CO Shift Catalyst	1,750 cu ft/2 yr
	Arsenic Guard Bed Catalyst	9,600 cu ft/6 mo

TABLE 8

WASTE CHARACTERISTICS FOR THE PROPOSED SANITARY LANDFILL

Source	Waste Type	Estimated Quantity	Compacted Volume
Construction Camp (Construction)	Inert Construction debris	100 tons	100yd^3
	Decomposable waste	150 tons/600 yd^3	300yd^3
Construction Camp (Operation)	Decomposable waste (dry trash)	5,000 tons/20,000yd^3	10,000yd^3
Plant Facility (Construction)	Inert construction debris	2,300 tons	2,300yd^3
	Decomposable waste	1,600 tons/6,400 yd^3	3,200yd^3
Total Inert Construction Debris		2,400 tons	2,400yd^3
Total Decomposable Waste		6,750 tons/27,000 yd^3	13,500yd^3
Total Landfill Waste		9,150 tons	15,900yd^3

wastes (especially the decomposable wastes) where estimates of exact waste quantity are uncertain. Therefore, the projected total waste quantity is probably overstated.

Paragraph 3

Inert wastes consist essentially of general construction debris such as concrete, brick, cinder blocks, soil, glass, ferrous and non-ferrous metals (scrap iron, steel, aluminum, copper, etc.), rubber and rubber products (tires, tubing, etc.), and plastic. Decomposable wastes include wood, paper and paper products, human trash and sanitary refuse (non-hazardous and non-septic), rags and other cloth, small amounts of fuel, lubricants, and anti-freeze, food and food containers, and kitchen waste.

During operations, a Stretford unit will be used to remove hydrogen sulfide from off-gases produced during retort operations. The wet sulfur cake product of the Stretford process will be melted to produce dry, crystalline sulfur for marketing or disposal. If the sulfur is not marketable, it will be placed in the retorted shale pile at a rate of 95 T/D.

Non-hazardous garbage and scrap generated by operations will be disposed in the retorted shale pile. This quantity is estimated to be 4.6 T/D and is based on a value of 7 lb/day/person.

All hazardous wastes generated during project operations will be disposed of off-site in an approved hazardous waste management facility. Wastes which may be classified as hazardous include API separator bottoms, air flotation unit float, oil filter particles, high temperature carbon monoxide shift catalyst, and arsenic guard bed catalyst. No hazardous wastes will be stored (for more than 90 days) or treated on-site.

Paraho will comply with the record keeping requirements of the hazardous waste generator and transporter manifest system. A notification of hazardous waste activity (EPA Form 8700-12) was provided to the Utah Division of Environmental Health, Bureau of Solid Waste, under separate cover.

Paragraph 4

Sanitary landfill runoff control was discussed under Hydrology, Rule M-3(1)(e).

Geology

Rule M-3(1)(e)

Possible seepage from the Birdsnest zone is expected to vary from 2 GPM to less that 5 GPM. No seepage is expected, the concrete liners of the shafts should prevent any seepage from entering the mine. If the concrete lining is not adequate containment, then other methods may be considered upon abandonment. If excessive seepage should occur with the concrete lining in place, the water encountered would be pumped for use as a dust suppressant within the mine.

Rule M-3(1)(g), M-10(2)(b)

At this time, it is not possible to determine the adequacy of the ponds or basins for disposal of foundation concrete upon reclamation. First, it is not certain which ponds will be available for this reclamation (i.e., those that will not be required to be maintained as ponds); this depends upon the results of the environmental monitoring to determine the quantity and quality of water impounded by these ponds or basins during the project. Second, overall reclamation may not be a concurrent event; some ponds may be reclaimed long before the operating plant (and foundation concrete) is reclaimed. Third, there are many other disposal alternatives for foundation concrete available to Paraho: canyon fill with proper soil cover and revegetation; back-filling, mine or mine shafts; disposal with retorted shale; use as fill for erosion control if needed. The "best" reclamation scheme cannot be fully addressed at this time.

Paraho

Rule M-3(2)(c)

These properties do contain gilsonite. We have been advised by American Gilsonite that their mining plans do not include these lands for the next ten years. Paraho does not plan to store raw shale fines in the mined out seams if they were available to Paraho. We are planning to lease these lands from American Gilsonite and, therefore, it will not be necessary for American Gilsonite to sign off on our plans.

Rule M-3(2)(c)

Since it is uncertain whether or not the sulfur produced from gas clean-up will be marketable (equipment manufacturer claims it will be; current uses claim otherwise), Paraho has taken a conservative approach and considers all sulfur produced to be waste. Should it prove to be marketable, Paraho would avoid all costs and impacts associated with solid waste disposal and market the sulfur instead.

Section 40-8-12

The mine area directly under the retorts and main buildings located in Section 32 will be mined last and will have no significant subsidence impact as our calculations show. The calculations are found in the Mine Plan, Attachment A, of the permit application.

Rule M-6

The drawings 8103-GY-G1, 8103-UM-G1, and 8103-GY-G2 of the Mine Plan, Attachment A, of the permit application illustrate the proposed access road and site access road.

The large folded Drawing 8103-GY-Gl shows the correct siting for the retention pond on Section 32.

Rule M-10(4)

Since the shale fines will probably be utilized as a feedstock; storage represents a conservative, worst-case approach and would only be used until a viable, economically attractive use for fines is developed. It is not planned that this storage area would remain for reclamation. As a conservative approach, Paraho has completed conceptual designs for raw shale fines storage which will serve as permanent storage with minimal adverse impacts. This design utilizes a thick layer of highly compacted retorted shale which previous research has shown to be both strong and impervious to water flow. This compacted material would be protected from weathering on the surface by a suitable soil cover and revegetation. The area is situated in a location that has no surface water runoff that could enter the disposal site. Only the sloped face would be subject to possible weathering; this has been mitigated by adding cement to the retorted shale prior to wetting and compacting. Research shows that, by adding about seven weight percent cement to the shale, the resistance to freeze-thaw deterioration is minimized and the mixture meets standard specification for long-term stability. No joints are required; small surface cracks that may develop will not cause any serious degradation of the storage site.

Rule M-10(6)

Paraho does not plan to dispose any hazardous waste on-site. Application for approved off-site disposal has been made (see response to Title 40-8-22).

Paraho

Slope Stability and Piller Design

Rule M-10(4)

Cross sections of the pre-existing and post mining topography are provided for the retorted shale storage pile, the raw shale fines - soil storage piles (Figures 6 - 10).

The following is Woodward Clyde's analysis of safety factors, including cross sections (Woodward Clyde Consultants, 1981. Preliminary Design Criteria for a Retorted Shale Disposal Facility, Paraho Commercial Feasibility Study).

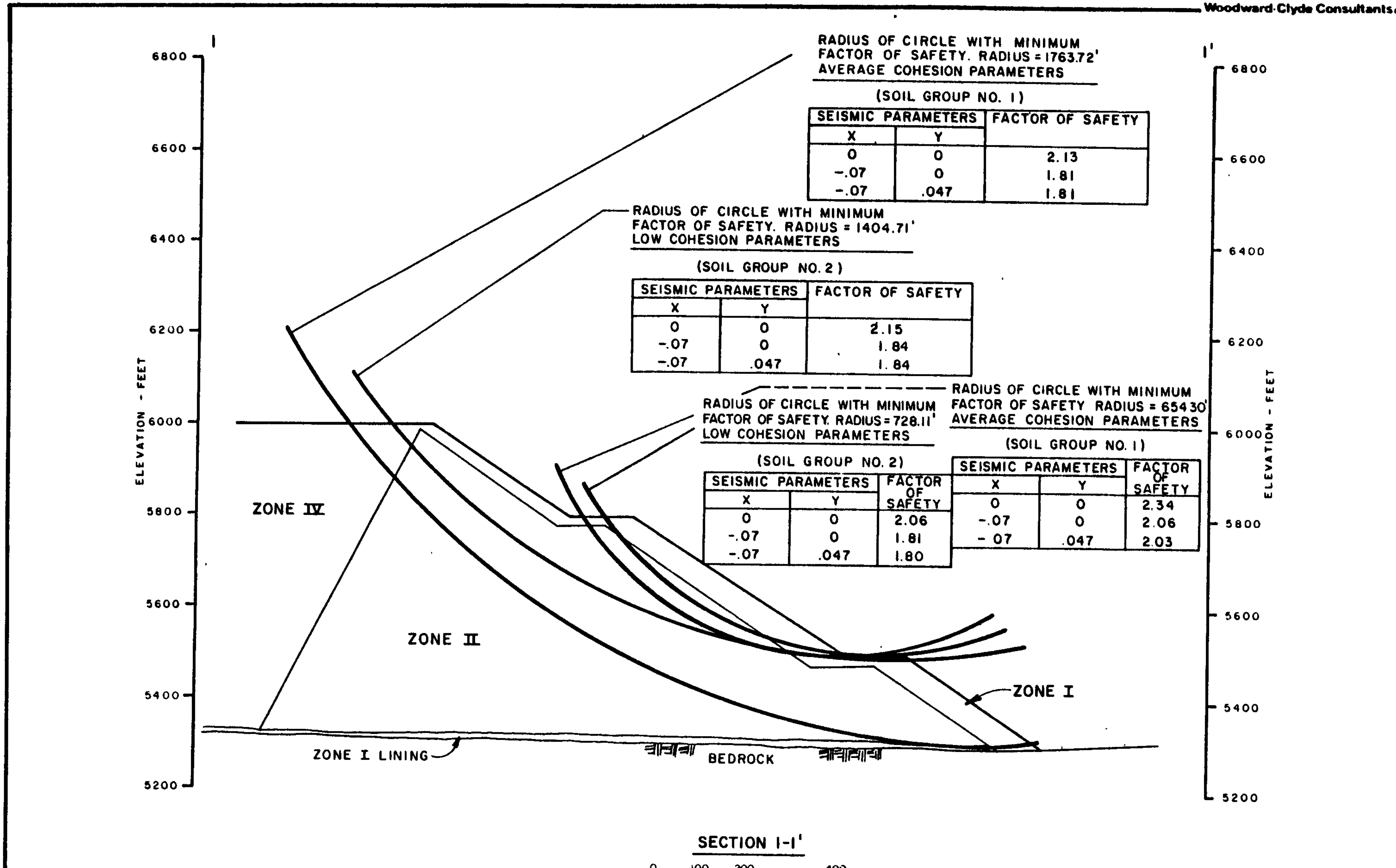
Embankment Stability Analyses

> Utilizing our experience gained during the Paraho Module Project, some generalized representative geotechnical sections along the facility embankments (both retorted shale and raw shale reject embankments) were used to investigate embankment stability, in a preliminary fashion, for the potentially high, steep disposal piles. We began with the assumption that a benched pile with an overall slope of the order of 1 3/4:1 (slope between benches 1 1/2:1) would be a reasonable starting point. Preliminary grade static and pseudo static stability analysis for the most critical case, Concept No. 1 embankment constructed to ultimate Elevation 6000, using the various retorted shale and raw shale reject material properties as outlined under "Material Properties," were completed. As a portion of this work, we completed a parametric study using average and low cohesion parameters. The purpose

of this study was to evaluate the effect of material property variations on safety factors predicted by conventional stability analysis techniques. Variations in material properties were limited to those that might occur under actual field conditions. Results of these studies are shown on Figures 15 through 19. Embankment configurations with both the Zone IV and Zone II materials backing up the Zone I were investigated. Based on these results, we believe overall embankment slopes of the order of 1 3/4:1 (benched disposal pile) are possible for any of the concepts being presented in this report.

Stability analysis results for Sections 1-1' and 2-2', materials with Zone II materials backing up Zone I materials are shown on Figures 15 and 16. Results of pseudo static analyses of these sections using the seismic parameters estimated at horizontal ground acceleration of between 0.05g - 0.07g are also given. Seismic acceleration components in the horizontal and both the horizontal and vertical directions (vertical equals two-thirds horizontal) were considered. As can be seen from the results of these analyses, the vertical component of acceleration has little effect on the minimum factors of safety at a given radius.

Stability analysis results for Sections 1-1' and 2-2' materials, with Zone IV materials backing up the Zone I, are shown on Figures 17 and 18. Results of pseudo static analyses of these sections using the seismic parameters as outlined above.



RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY. RADIUS = 1763.72' AVERAGE COHESION PARAMETERS

(SOIL GROUP NO. 1)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.13
-.07	0	1.81
-.07	.047	1.81

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY. RADIUS = 1404.71' LOW COHESION PARAMETERS

(SOIL GROUP NO. 2)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.15
-.07	0	1.84
-.07	.047	1.84

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY. RADIUS = 728.11' LOW COHESION PARAMETERS

(SOIL GROUP NO. 2)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.06
-.07	0	1.81
-.07	.047	1.80

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY RADIUS = 654.30' AVERAGE COHESION PARAMETERS

(SOIL GROUP NO. 1)

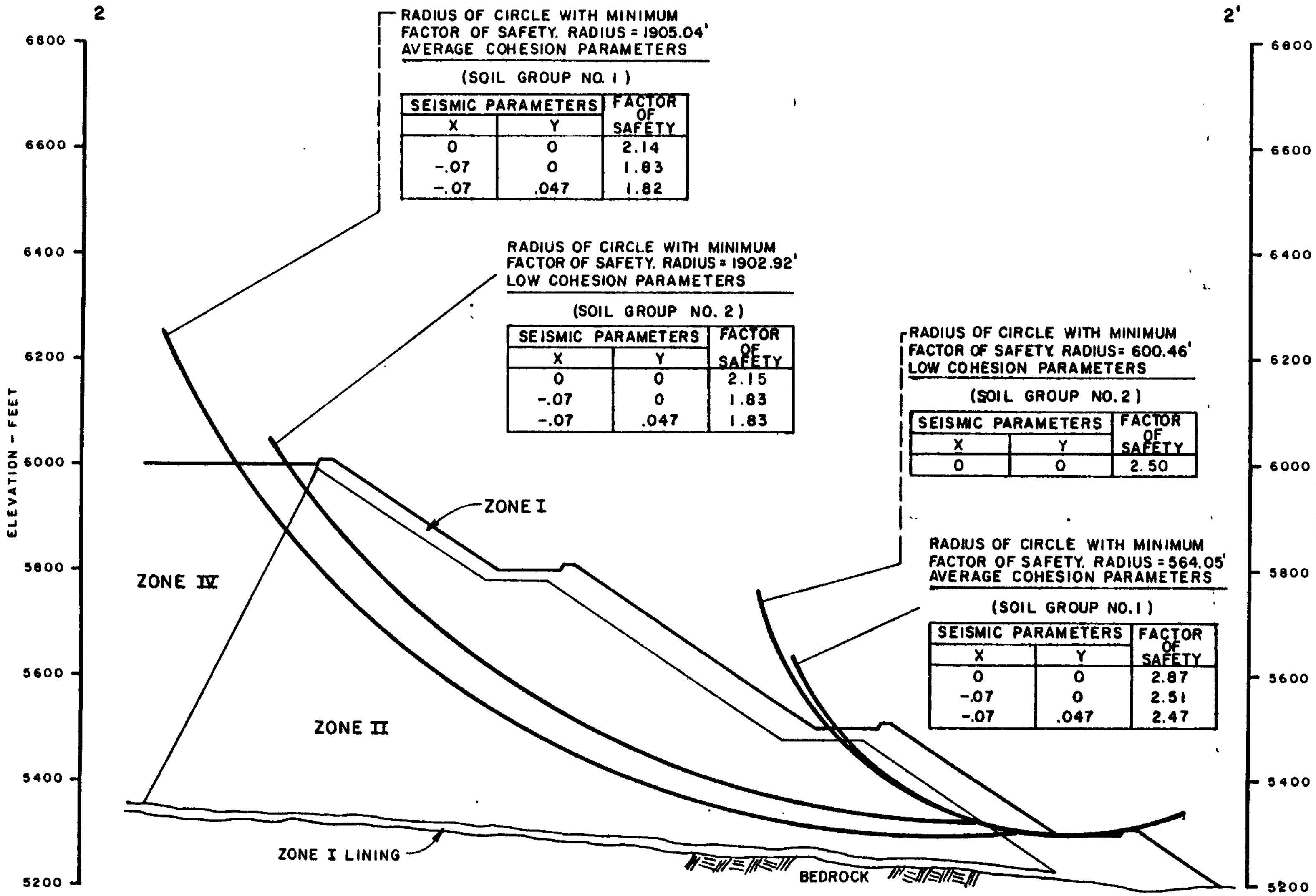
SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.34
-.07	0	2.06
-.07	.047	2.03

FOR NOTES, SEE FIGURE 18

Job No 20228 - 20086	SUMMARY OF STABILITY ANALYSIS RESULTS SECTION I - I' EMBANKMENT CONSTRUCTED WITH A ZONE II
Prepared by: L.R.N./l m m.	
Date 4/23/81	

FIG. 15

Woodward-Clyde Consultants



RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY. RADIUS = 1905.04' AVERAGE COHESION PARAMETERS

(SOIL GROUP NO. 1)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.14
-.07	0	1.83
-.07	.047	1.82

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY. RADIUS = 1902.92' LOW COHESION PARAMETERS

(SOIL GROUP NO. 2)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.15
-.07	0	1.83
-.07	.047	1.83

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY. RADIUS = 600.46' LOW COHESION PARAMETERS

(SOIL GROUP NO. 2)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.50

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY. RADIUS = 564.05' AVERAGE COHESION PARAMETERS

(SOIL GROUP NO. 1)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.87
-.07	0	2.51
-.07	.047	2.47

SECTION 2-2'

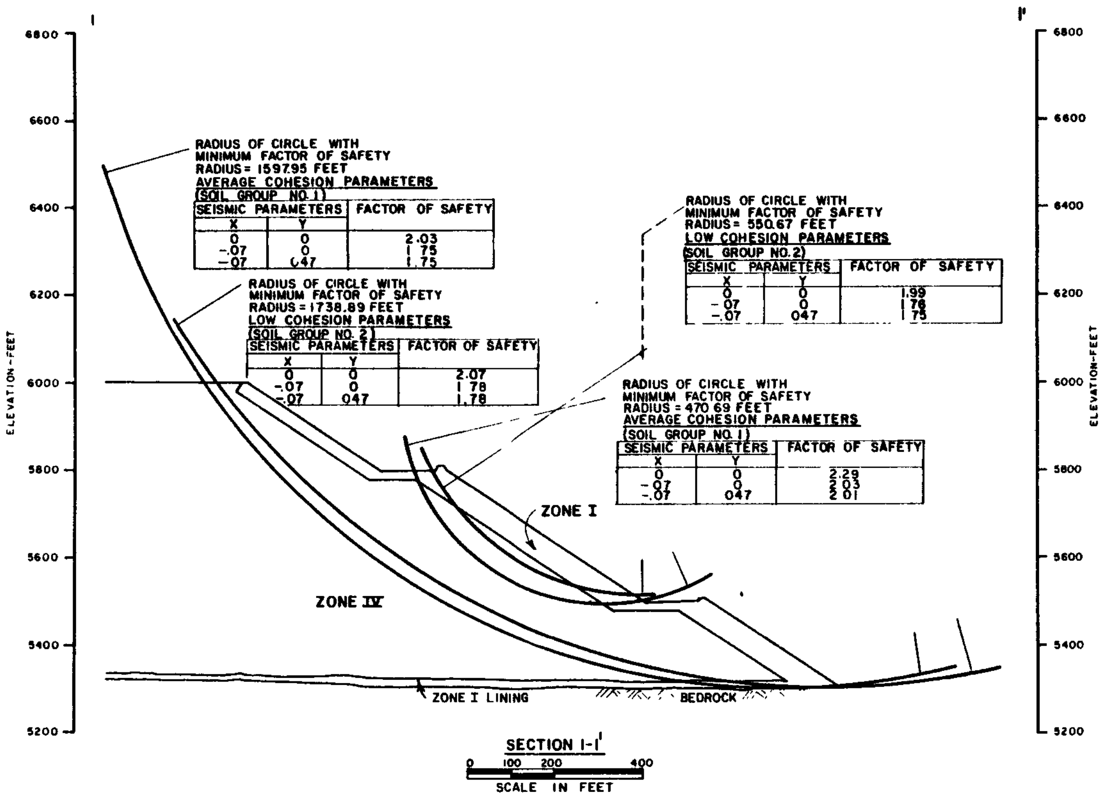
0 100 200 400

SCALE IN FEET

FOR NOTES, SEE FIGURE 18

Job No.: 20228-20086	SUMMARY OF STABILITY ANALYSIS RESULTS SECTION 2-2' EMBANKMENT CONSTRUCTED WITH A ZONE II
Prepared by: L.R.N./m.m.y	
Date: 4/23/81	

FIG. 16



RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY
RADIUS = 1597.95 FEET
AVERAGE COHESION PARAMETERS
(SOIL GROUP NO. 1)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.03
-.07	0	1.75
-.07	.047	1.75

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY
RADIUS = 1738.89 FEET
LOW COHESION PARAMETERS
(SOIL GROUP NO. 2)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.07
-.07	0	1.78
-.07	.047	1.78

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY
RADIUS = 550.67 FEET
LOW COHESION PARAMETERS
(SOIL GROUP NO. 2)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	1.99
-.07	0	1.76
-.07	.047	1.75

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY
RADIUS = 470.69 FEET
AVERAGE COHESION PARAMETERS
(SOIL GROUP NO. 1)

SEISMIC PARAMETERS		FACTOR OF SAFETY
X	Y	
0	0	2.29
-.07	0	2.03
-.07	.047	2.01

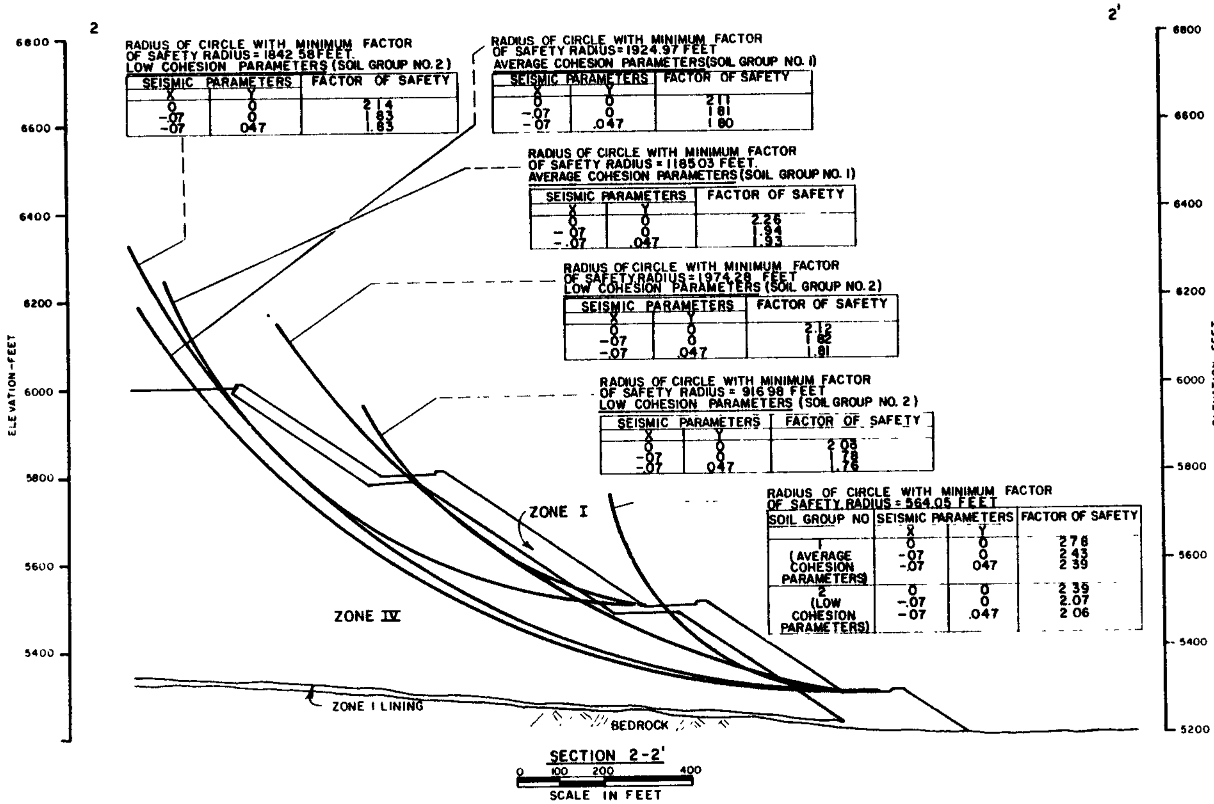
FOR NOTES, SEE FIGURE 18

Job No	20228-20086
Prepared by	KAF/b.r
Date	4/14/81

SUMMARY OF STABILITY ANALYSIS RESULTS
SECTION I-I'
EMBANKMENT CONSTRUCTED WITHOUT A ZONE II

FIG 17

Woodward-Clyde Consultants



RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY RADIUS = 1842 58 FEET.
LOW COHESION PARAMETERS (SOIL GROUP NO. 2)

SEISMIC PARAMETERS X	SEISMIC PARAMETERS Y	FACTOR OF SAFETY
0	0	2 14
-07	0	1 83
-07	047	1.83

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY RADIUS = 1924.97 FEET
AVERAGE COHESION PARAMETERS (SOIL GROUP NO. I)

SEISMIC PARAMETERS X	SEISMIC PARAMETERS Y	FACTOR OF SAFETY
0	0	2 11
-.07	0	1 81
- 07	.047	1 80

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY RADIUS = 1185 03 FEET.
AVERAGE COHESION PARAMETERS (SOIL GROUP NO. I)

SEISMIC PARAMETERS X	SEISMIC PARAMETERS Y	FACTOR OF SAFETY
0	0	2.26
- 07	0	1.94
-.07	.047	1.93

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY RADIUS = 1974.28 FEET
LOW COHESION PARAMETERS (SOIL GROUP NO. 2)

SEISMIC PARAMETERS X	SEISMIC PARAMETERS Y	FACTOR OF SAFETY
0	0	2.12
-07	0	1 82
-.07	.047	1.81

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY RADIUS = 916 98 FEET
LOW COHESION PARAMETERS (SOIL GROUP NO. 2)

SEISMIC PARAMETERS X	SEISMIC PARAMETERS Y	FACTOR OF SAFETY
0	0	2 08
-07	0	1 78
-.07	047	1.76

RADIUS OF CIRCLE WITH MINIMUM FACTOR OF SAFETY RADIUS = 564.05 FEET

SOIL GROUP NO	SEISMIC PARAMETERS X	SEISMIC PARAMETERS Y	FACTOR OF SAFETY
1 (AVERAGE COHESION PARAMETERS)	0 -07 -07	0 0 047	2 78 2 43 2 39
2 (LOW COHESION PARAMETERS)	0 -.07 -07	0 0 .047	2 39 2.07 2 06

NOTES:

1.

SOIL GROUP NUMBER	SOIL ZONE	MOIST UNIT WEIGHT γ (pcf)	COHESION c (psf)	FRICTION ANGLE (degrees)	COMMENTS
1	I II IV BEDROCK	120.0 99.0 86.0 145.0	5000 3300 2700 360,000	34 34 34 34	AVERAGE COHESION PARAMETERS
2	I II IV BEDROCK	120.0 99.0 86.0 145.0	2500 1650 1350 360,000	38.7 38.7 38.7 34.0	LOW RANGE COHESION PARAMETERS

2. ANALYSES WERE PERFORMED ON A COMPUTER USING THE APPLIED GEODATA SYSTEMS, INC. "LEASE" PROGRAM BASED UPON A MODIFIED BISHOP ANALYSIS.

3. AN AVERAGE OF 330 CIRCLES WERE ANALYZED TO IDENTIFY EACH CRITICAL FAILURE SURFACE.

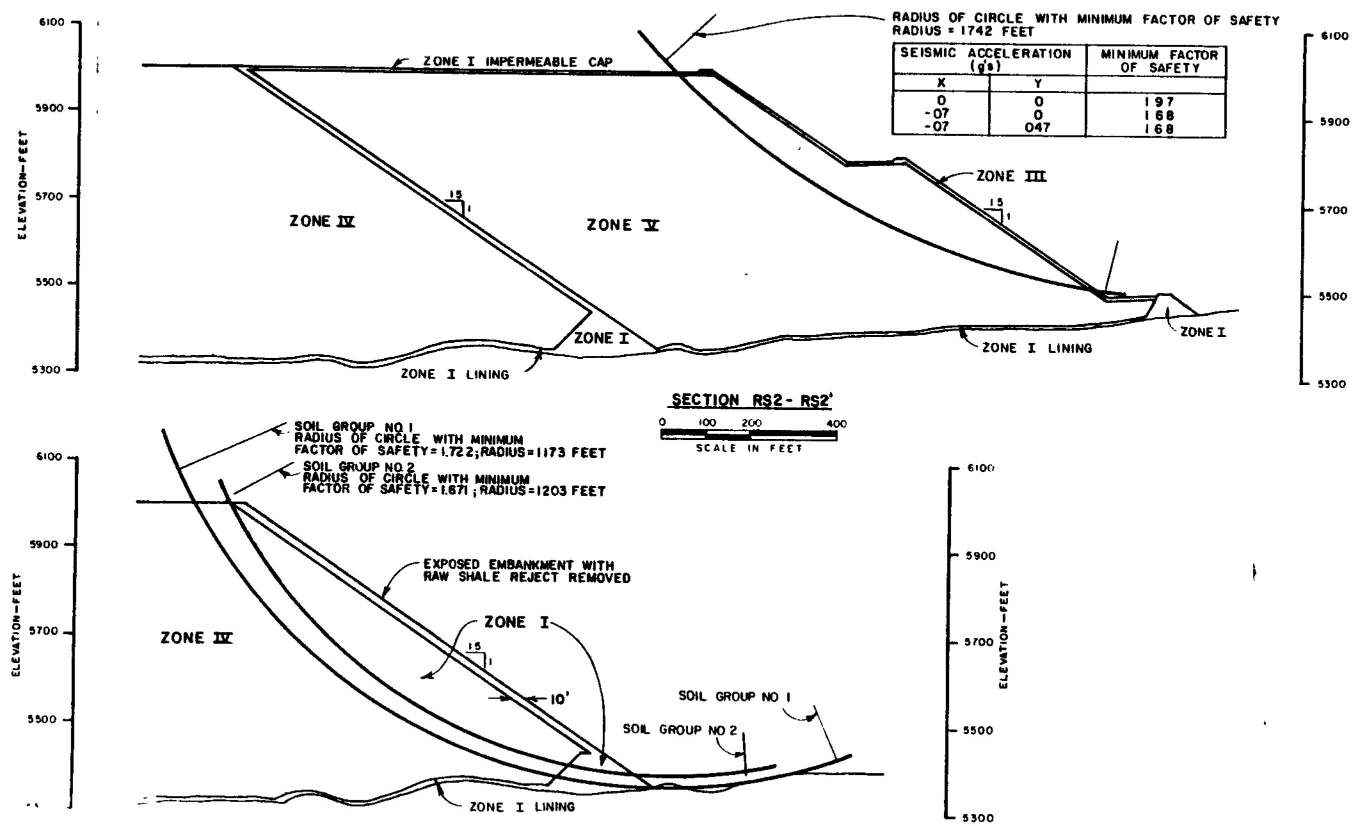
4. HORIZONTAL AND VERTICAL SEISMIC ACCELERATIONS ARE POSITIVE TO THE LEFT AND DOWN.

5. SECTIONS ILLUSTRATED ARE FOR CONCEPT #1, CONSTRUCTED TO ELEVATION 6000 FEET (SEE FIGURE 11).

Job No: 20228-20086	SUMMARY OF STABILITY ANALYSIS RESULTS SECTION 2-2' EMBANKMENT CONSTRUCTED WITHOUT A ZONE II
Prepared by: K A F / br	
Date: 4/14/81	

FIG 18

Woodward Clyde Consultants



SEISMIC ACCELERATION (g's)		MINIMUM FACTOR OF SAFETY
X	Y	
0	0	1.97
-.07	0	1.68
-.07	.047	1.68

NOTES:

1. SOIL PROPERTIES USED IN ANALYSES:

SOIL GROUP NUMBER	SOIL ZONE	MOIST UNIT WEIGHT (pcf)	COHESION C (psf)	FRICTION ANGLE φ (degrees)
1	I IV BEDROCK	120 86 145	5000 2700 360,000	34 34 34
2	I IV BEDROCK	120 86 145	5000 1350 360,000	34 38.7 34
	III	120	5000	34
	V	93	1150	37

2. SEISMIC ACCELERATIONS WERE CONSIDERED FOR RAW SHALE REJECT MATERIALS EMBANKMENT ONLY.

3. ANALYSIS WERE PERFORMED ON A COMPUTER USING THE APPLIED GEODATA SYSTEMS, INC. "LEASE" PROGRAM BASED UPON A MODIFIED BISHOP ANALYSIS.

4. A MINIMUM OF 275 CIRCLES WERE ANALYZED.

Job No 20228-20086	**STABILITY ANALYSIS RESULTS** RAW SHALE REJECT AND INTERIOR RETORTED SHALE CONTAINMENT EMBANKMENT TO ELEVATION 6000
Prepared by SJE/br	
Date 4/14/81	

FIG 19

As can be seen on these figures, both shallow and deep potential failure surfaces were indicated by the analysis. The shallow failures were typically controlled by the cohesion parameters more than the angle of internal friction. Therefore, the average cohesion values assumed in the analysis gave higher factors of safety than the low cohesion parameters. Deep failures through regions of higher normal stress indicate frictional characteristics of a material predominate over cohesion. As can be seen from the results presented on these figures, the low cohesion parameters and associated higher angles of internal friction produce the higher factors of safety for the deep failure circles over the average cohesion parameters with lower angles of internal friction. For the parameters used in our analyses, when failure circles are generally deeper then 100 feet (approximately 10,000 psf normal stress), stability analyses show the low friction, high cohesion parameters produce the minimum factors of safety.

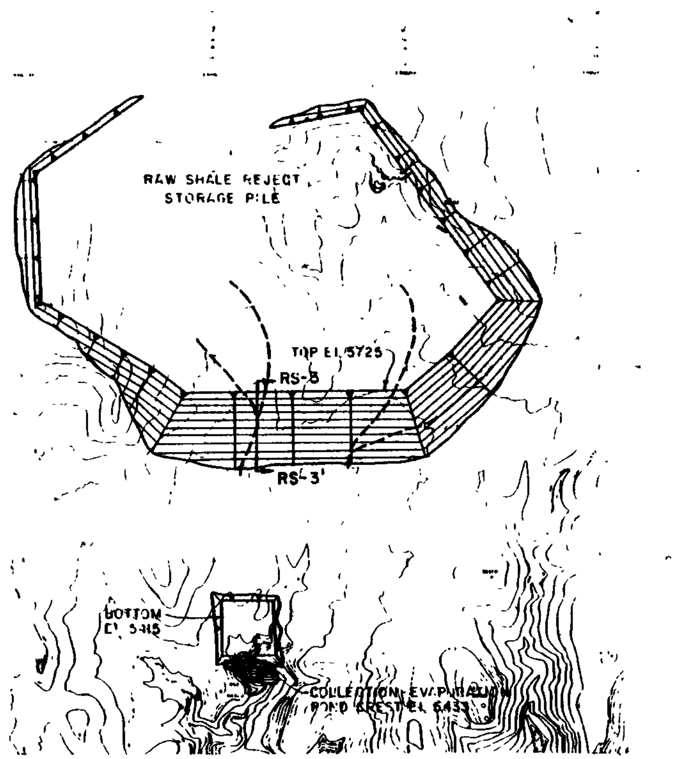
Comparing the stability analyses results for the embankment configuration utilizing Zone II with the embankment configuration utilizing Zone IV, it can be seen that many factors affect embankment stability. Although the Zone II materials are stronger, for several deep failure circles it can be seen that the potential failures through the Zone II do not have a significantly larger factor of safety than similar deep circle potential failure surfaces through the Zone IV materials. This fact is attributed in part to the increased unit weight (and resulting increased driving force) of Zone II over Zone IV materials, which is not offset by the increased strength of Zone II materials.

Results of stability analyses for a generalized raw shale reject embankment section (RS2-RS2') are shown on Figure 17. We assumed an ultimate embankment elevation of 6000 feet and a 1 1/2:1 exterior embankment slope. Seismic acceleration components in the horizontal and both the horizontal and vertical directions were considered.

Results of stability analyses for a generalized Concept No. 4 raw shale reject embankment section (RS3-RS3') are shown on Figure 20. The ultimate embankment elevation was assumed at 5725 feet and the exterior embankment slope was 1 1/2:1. Seismic acceleration components in the horizontal and both the horizontal and vertical directions were considered.

Preliminary grade stability analyses were performed on a section of the interior retorted shale embankment assuming that the raw shale reject materials had been removed. Results of this preliminary analysis are shown on Figure 19. Seismic acceleration components were not introduced into this analysis due to the potentially short duration exposure of the embank- ment. Results of this study indicate that the interior retorted shale containment constructed with a slope of the order of 1 1/2:1 should be stable.

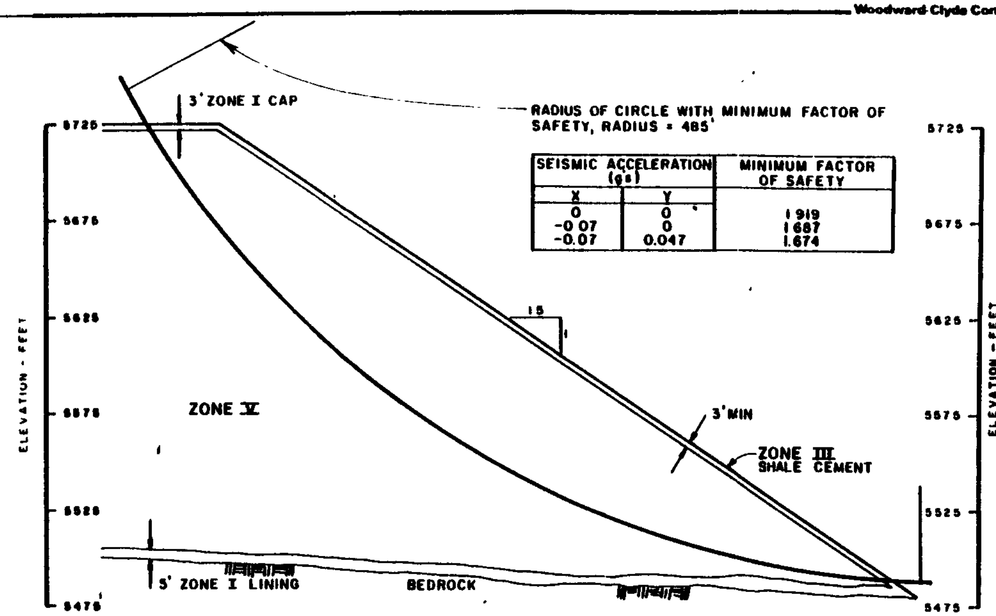
In all cases studied, the theoretical safety factors are quite adequate and well within the limits of good engineering practice. The embankment safety factors are shown on stability analyses Figures 15 through 19.



CONCEPT 4

COLLECTION-EVAPORATION POND DATA:

EXCAVATION REQUIRED APPROX. 83 400 yd³
EMBANKMENT VOLUME - APPROX. 8 500 yd³
LINING THICKNESS - 3.5 FEET
EMBANKMENT SLOPES - 2 HORIZONTAL TO 1 VERTICAL
CUT SLOPES - 1 HORIZONTAL TO 1 VERTICAL. CUT SLOPES ADJACENT TO EMBANKMENT SLOPES MATCH AT 2 HORIZONTAL TO 1 VERTICAL.



SEISMIC ACCELERATION (gs) X	Y	MINIMUM FACTOR OF SAFETY
0	0	1.919
-0.07	0	1.687
-0.07	0.047	1.674

SECTION RS3 - RS3'

NOTES:

1. SOIL PROPERTIES USED IN ANALYSIS

SOIL ZONE	MOIST UNIT WEIGHT (pcf)	COHESION C (psf)	FRICTION ANGLE φ (degrees)
I & III	120	5000	34
V	93	1150	37
BEDROCK	145	360,000	34

2. ANALYSES WERE PERFORMED ON A COMPUTER USING THE APPLIED GEODATA SYSTEMS, INC. "LEASE" PROGRAM BASED UPON A MODIFIED BISHOP ANALYSIS.
3. A MINIMUM OF 245 CIRCLES WERE ANALYZED.
4. SOUTHERN TOE TRACE LOCATION PROVIDED BY SOHIO.

Job No: 20228-2008A	CONCEPT 4
Prepared by: KA / lmm	LAYOUT, AREA-CAPACITY CURVES AND STABILITY ANALYSIS RESULTS
Date: 4/21/81	

Figure 20

Parameter

Results of stability analyses completed for foundation areas where potential instability, due to large disposal pile loadings that may occur, indicate that residual strength properties of potential weak planes in foundation bedrock areas should be capable of supporting normal and lateral loads imposed by any of the concepts being presented. A minimum, worst case, factor of safety from our analysis was of the order of 1.9 for the maximum loading conditions imposed by the Concept No. 1 pile constructed to ultimate Elevation 6000.

Rule M-3(3)

Results from exploratory drilling operations show that no water will be encountered in mining horizon.

Rule M-10(2)

Paraho is not planning over-sized pillars in the mine. However, the average size of pillars should be adequate for future gas drilling.

Rule M-3(1)(d)

The pipeline that crosses the proposed diversion cut is the Wesco Pipeline that transports crude oil to the Gary Western Refinery at Fruita, Colorado. Paraho will negotiate the rerouting of the pipeline with Wesco.

The Mountain Fuel Supply Pipeline crosses Section 32. Mining will be done under the pipeline. The mine is designed so there will be no surface subsidence. There will be an on-going monitoring of rock movement in the mine as well. Paraho has contacted Mountain Fuel Supply Pipeline concerning construction and operation of the Paraho-Ute project and if necessary, their pipeline may be rerouted.

The abondoned retort is situated about twenty-five feet above the present White River several hundred feet downstream from the canyon proposed as the retorted shale disposal area. The location will not be destroyed either by the proposed White River Dam nor the Paraho-Ute project. The abandoned retort site was fully described in the on-site archaeological report prepared by Nickens and Associates of Montrose, Colorado and was provided to Division of State History and the BLM District Office in Vernal, Utah. Nevertheless, Paraho has obtained recent photographic documentation of the area which is available, if needed.

Title 40-8-22

Paraho will have made application by December 31, 1982 for all permits necessary to construct the Paraho-Ute Facility. A list of these permits is attached (see Table 9).

TABLE 9

Permit	Application Date	Status
R-O-W	May 1981	Anticipated Approval: February 1983
	Sept 1981	Anticipated Approval: February 1983
	(Nov 1982)	Anticipated Approval: February 1983
Exploratory Drilling	July 1980	Approved: August 1980
	Dec 1980	Approved: January 1981
	Aug 1982	Approved: September 1982
NPDES	May 1982	Anticipated Approval: November 1982
Hazardous Waste	May 1982	June 1982
404	(Nov 1982)	Anticipated Approval: April 1983
PSD	Nov 1981	Anticipated Approval: November 1982
Mining	Mar 1982	Anticipated Approval: December 1982
Solid Waste	May 1982	Approval: June 1982 (Construction) Approval: September 1982 (Operations)
Dams & Impoundments	(Dec 1982)	
Alter Natural Stream	May 1982	Approved: June 1982
Wastewater Disposal	(Dec 1982)	
Drinking Water	(Dec 1982)	
Labor Camp Sanitation	(Dec 1982)	
Building Permit	(Dec 1982)	
Food Service Sanitation	(Dec 1982)	

Paraho

Bonding (Rule M-5)

The reclamation costs, listed in Tables 5.1 and 5.2 (Paraho Reclamation Plan, Attachment B, Mine Permit Apoplication) were developed by Paraho contractors, Cliff's Engineering, Inc. (CEI) and Davy-McKee Corporation (DMC) under the Paraho Module Program and the Paraho Commercial Feasibility Study. Details of mine-related, surface reclamation, and monitoring costs have been prepared by CEI. Details of the costs incurred for the removal of plant buildings and structures have been prepared by DMC.

The basis for CEI's data is found in the attachment "Paraho Commercial Feasibility Study, Abandonment Plan, Task 17" (see Tables 2.1, 3.1, 4.1, 5.1, 6.1, and 6.2). The basis for DMC's cost estimate, $40,600,000 is presented in Table 10.

In Table 11, the net costs of reclamation have been presented taking into consideration the estimates of the overall reclamation costs and the salvage value of buildings and structures. A salvage value of 10% of original value is assumed for all structures, equipment, and materials. Once the facility is constructed, the salvage value exceeds the overall reclamation costs, and the net costs become zero.

Parah

TABLE 10
Abandonment Costs
(Removal of Plant Buildings and Structures)

Assumptions:

(1)	Installed Buildings and Structures	100,000 Tons
(2)	Installation Labor	8,522,000 Manhours

Thus, labor/ton for installation is: 85 Manhours/Ton

Assumptions:

(1)	Labor/Ton for Abandonment	25 Manhours/Ton
(2)	Labor Costs	$16.07 Hour

Thus, labor costs for abandonment is:

$$25 \frac{\text{manhours}}{\text{ton}} \times 100{,}000 \text{ Ton} \times 16.07 \frac{\$}{\text{hr}} = 40.6 \text{ million dollars}$$

<u>Excusions</u>:

- Reclamation/Revegetation Costs (by CCI)
- Shutdown Costs
- Shipping, Storage & Brokerage of Salvageable Materials
- Sales and Use Tax
- Escalation
- Contingency
- Professional Services
- Field Indirect Costs
- Insurance

TABLE 11
Phased Net Reclamation Costs[a]
(To Nearest Thousand Dollar)

Time Period	BUILDING & STRUCTURE VALUE This Period	BUILDING & STRUCTURE VALUE Cumulative	SALVAGE[c] VALUES (Cumulative)	ABANDONMENT[d]	NET RECLAMATION COSTS[e]
Site Development	$ 0	$ 0	$ 0	$ 53	$ 53
Construction-One Retort	350,533	350,533	35,053	9,314	0
Construction-Full Plant	514,954	865,487	86,548	19,029	0
Full Operation (1988-1994)	189,815	1,055,302	105,530	45,012	0

[a]Costs do not include indirect costs, contractor's fees, taxes, insurance, escalation, contingency, etc. All costs are in 1981 dollars.
[b]Taken from Paraho-Ute Project "Capital Investment Schedule".
[c]Salvage value is 10% of estimated cumulative value.
[d]Taken from Table 5.2 Abandonment Costs - Detailed in the Paraho Reclamation Plan (Attachment C).
[e]Actual value is cumulative value less salvage value.

Paraho

As shown in Table 11, the salvage value exceeds the overall abandonment costs. This indicates that most of the abandonment costs associated with removal of the plant buildings and structures consists of removal of salvageable items. It is estimated that only one-fifth of these abandonment costs consist of removal of the non-salvageable equipment (scrap, foundations, etc.). Thus, the abandonment costs associated with plant buildings (shown in Table 5.2, Paraho Reclamation Plan) should reach a maximum of $8,120,000. On this basis, valid overall reclamation costs for the Paraho-Ute site would be:

Site Development	Late 1983	$ 53,000
Construction (One Retort)	Late 1985	2,818,000
Construction (Full Plant)	Late 1988	6,836,000
Operation	1994	12,532,000

DIVISION OF OIL, GAS & MINING

APPARENT COMPLETENESS REVIEW

<u>PARAHO COMMERCIAL FEASIBILITY STUDY</u>

<u>ABANDONMENT PLAN</u>

<u>TASK 17</u>

NOVEMBER 10, 1981

PARAHO COMMERCIAL FEASIBILITY STUDY
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1.0 INTRODUCTION AND APPLICABLE GOVERNMENTAL REGULATIONS

Pursuant to the Mined Land Reclamation Act, the State of Utah requires that all mined land abandoned after June 1978 be reclaimed in a manner which is capable of supporting a post-mining use that is compatible with probable land uses. This Task report presents a discussion of, and costs associated with, abandonment of the Paraho Commercial Plant at the end of its scheduled operation. In summary, this activity will require removal of all surface facilities and debris, recontouring of the land surface, sealing of all mine portals and shafts, and revegetation of all disturbed areas.

1.1 Applicable Governmental Regulations for Underground Mine Abandonment:

State of Utah, Mined Land Reclamation Act, Title 40-8 Utah Code Annotated 1953.

State of Utah, Mined Land Reclamation General Rules and Regulations and Rules of Practice and Procedure, Rule M-10 Reclamation Standards.

Federal Metal and Nonmetallic Mine Safety and Health Regulations, 30 CFR (57.20-21).

2.0 MINE ABANDONMENT

Available stratigraphic and structural information indicates that the mine workings will not act as a conduit between aquifers. The Bird's Nest aquifer is approximately 300 feet above the mining horizon and the only other potential aquifer zone is at least 1,300 feet below the mining horizon; therefore, water will not flow between aquifers. Moreover, the Bird's Nest aquifer has a very low transmissivity. Consequently, the only consideration that mine abandonment requires is the removal of salvageable equipment and ventilation fans and the sealing of the mine shaft and mine portals.

The service shaft will be sealed by forming and pouring an 18-inch-thick concrete plug at the shaft surface. This concrete slab will be supported by existing structural steel in the shaft, augmented with additional structural steel where needed. The ventilation shafts will also be sealed by forming and pouring 18-inch-thick concrete plugs; however, in this case, no existing structural steel is available in-place. The costs shown in Table 2.1 reflect the need for structural steel installation to support the concrete slabs. The mine portals will be sealed by constructing a concrete wall within 20 feet of the entrance. Suitable rock and earth materials will be backfilled against the wall to camouflage the openings. As indicated in Table 2.1, the estimated total cost for this work is $113,700.

PARAHO COMMERCIAL FEASIBILITY STUDY
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TABLE 2.1

MINE ENTRANCE SEALING COST

SERVICE SHAFT - 30-FOOT-DIAMETER:	
Structural Steel Reinforcement 18-Inch Concrete Slab (40 yds^3 x $333/$yd^3$)	$ 18,300
VENTILATION SHAFT - 34-FOOT-DIAMETER:	
Structural Steel Installation 18-Inch Concrete Slab (50.5 yds^3 x $333/$yd^3$)	$ 39,800
VENTILATION SHAFT - 24-FOOT-DIAMETER:	
Structural Steel Installation 18-Inch Concrete Slab (25 yds^3 x $333/$yd^3$)	$ 26,400
CONVEYOR INCLINE - 14 FEET BY 16 FEET:	
18-Inch Concrete Wall (12.5 yds^3 x $333/$yd^3$)	$ 4,200
VENTILATION PORTAL - 30 FEET BY 45 FEET:	
18-Inch Concrete Wall (75 yds^3 x $333/$yd^3$)	$ 25,000
TOTAL	$113,700

3.0 MINE SURFACE FACILITIES ABANDONMENT

Mine surface facilities include the service building (which houses office and change room facilities, a warehouse, first aid station, and maintenance and repair shop facilities), a 60-foot by 150-foot cold storage facility, a 24-foot by 42-foot lubricant storage/dispensing building, a waste water treatment facility, three explosives storage magazines, an ammonium nitrate/fuel oil mixing facility, the service shaft headframe and the hoist house. When the Paraho Commercial Plant ceases operation, these surface installations will be removed and the disturbed areas (including the retorted shale and raw shale fines piles) will be reclaimed and revegetated.

Table 3.1 presents a listing of the various surface buildings that will require removal and disposal at the end of the Commercial Plant operation. Also presented are the costs associated with this work. In preparing these costs, the assumption was made that the buildings themselves possess no salvage value. The costs shown include demolition and removal of the material for disposal at a suitable on-site location. The total cost for removal and disposal of the surface buildings is $1,247,000.

Since the life of the Paraho Commercial Plant is scheduled to exceed nine years, we have assumed that mobile, shop, mine and surface equipment will possess no salvage value.

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TABLE 3.1

MINE SURFACE BUILDING DEMOLITION & REMOVAL COSTS

Mine Service Building	$1,045,000
Cold Storage Building	19,500
Lubricant Storage Building	16,500
Service Shaft Headframe & Hoist House	166,000
TOTAL	$1,247,000

4.0 DISTURBED LAND RECLAMATION AND REVEGETATION

Under the provisions of the Mined Land Reclamation Act, the State of Utah requires that disturbed lands be revegetated with a self-sustaining cover of nonnoxious perennial plants. The cover shall be a diverse mixture of grasses, forbs, and shrubs. Previous revegetation studies of arid lands in Utah suggest that western wheat grass, crested wheat grass, fourwing salt brush, greasewood, winterfat, black sagebrush, Indian rice grass, yellow sweet clover, pubescent wheat grass and rabbit brush are plant species suited to this purpose. They are tolerant of above-average salinity and alkalinity and would be compatible with livestock grazing and wildlife needs.

We estimate that approximately 400 acres of disturbed lands will require reclamation and revegetation. This includes the lands previously occupied by mine-related surface buildings, the surface of the retorted shale and raw shale fines piles, and the area where preproduction ore and surficial soils are temporarily stored.

Land reclamation will require recontouring and grading of the surface building sites to approximate the original slopes. It will be necessary to grade these areas to provide terraces that minimize erosion, to prevent heavy sedimentation loads from contaminating the White River, and to permit the establishment of a vegetative cover. Following the initial recontouring step, surficial soils, which had been stripped from these areas and stored prior to construction, will be replaced to a minimum thickness of 12 inches.

Similarly, the tops of the retorted shale pile and the raw shale fines pile must be contoured in broad terraces sloping toward the center of the piles during the final placement of materials on these piles. In this case, it will be necessary to spread a six-inch layer of coarse material on top of both piles to prevent upward capillary movement of saline and sodic water from the piles. Fines reject from the rock riprap grading process (screened to +1/4-inch) may be suitable for this use. Approximately 24 inches of stored surficial material will be spread over the layer of coarse material.

An approximate six-inch layer of topsoil, spread uniformly to retain the required slope and terraces, will be placed over the surficial soils layer that covers the reclaimed building sites and the retorted shale and raw shale fines piles. Scrapers, dozers, and graders will be used to pick up and spread surficial material and topsoil. Compaction of all layers replaced will approximate that of natural surrounding soil.

A two-phase approach is planned to establish vegetation.

1. Fertilize and seed the entire area with adapted grasses and shrubs. Shrubs will require irrigation during the first and possibly during the second years. Following seeding, the areas should be crimp mulched with hay or straw to retain moisture in the soil and to aid in surface stabilization.

2. Transplant container-grown shrubs and perennial grasses to assure sparse vegetation cover immediately.

Reapplication of fertilizer is recommended during the second and third years. Irrigation pipe and a pump will be required to pump water from the river during the first and second years. The estimated irrigation water requirements are based on augmenting natural precipitation by adding the equivalent of 12 annual inches during the first year and six inches during the second year. These requirements equate to 400 acre feet and 200 acre feet, respectively, for the first and second years.

Table 4.1 presents a detailed listing of costs associated with reclamation and revegetation of the surface building sites, the retorted shale pile, the raw shale fines pile, and the area which had been covered by the preproduction stockpile and surficial soils during storage. The table indicates that the total cost for this reclamation and revegetation work is $2,824,300 for the first year. The second and third year costs are $328,000 and $117,250, respectively.

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TABLE 4.1

RECLAMATION AND REVEGETATION COSTS

BUILDING SITE AND DISTURBED AREAS:	
Recontouring and Grading of Building Sites (approximately 35 acres)	$ 16,800
Surficial Soils Placement (minimum 12-inch thickness, approximately 100 acres)	161,000
Soil Preparation, Fertilization, Planting, and Mulching (100 acres)	180,000
Irrigation Supplies (100 acres @ $900/acre including first year labor @ $200/acre and water)	120,000
Subtotal	$ 477,800
RETORTED SHALE AND RAW SHALE FINES PILES: (Approximately 300 Acres)	
Six-Inch-Layer of +1/4-inch material placed on pile surfaces	$ 241,500
Surficial and Topsoil Placement (minimum 30-inch thickness)	1,205,000
Soil Preparation, Fertilization, Planting, and Mulching	540,000
Irrigation Supplies ($900/acre including first year labor @ $200/acre and water)	360,000
Subtotal	$2,346,500
GRAND TOTAL	$2,824,300
SECOND YEAR COST (Fertilization, Water, & Irrigation):	$ 328,000
THIRD YEAR LABOR COST (Fertilization):	$ 117,250

5.0 RETORTED SHALE DISPOSAL AREA MONITORING

When the Paraho Commercial plant ceases operation and the retorted shale pile is completed, a monitoring program will be initiated to evaluate the stability and performance of the pile. Monitoring will include measurements of pile moisture, phreatic water levels, temperature, leachate water quality, and embankment stability. The data gained will be useful in the design of future disposal sites and will provide verification of various environmental safeguards incorporated into the pile design.

The brief outline that follows summarizes the parameters to be monitored, the monitoring equipment needed, and the recommended monitoring frequency:

1. Pile Moisture - Five locations in retorted shale pile. Use nuclear probe inside aluminum-cased holes at a frequency of once per month for two to three years.

2. Water Levels - Five locations in retorted shale and two locations in the raw shale fines piles using slotted pipe, open well piezometers, and a sensing probe for water level determinations. Frequency should be once per month for two to three years.

3. Pile Temperature - Eight locations (at 20-foot increments at each location) in the retorted shale pile and two locations in the raw shale fines pile, using thermocouples. Frequency should be twice per month until a pattern is established.

4. Leachate Concentrations - Water samples should be taken from the open well piezometers for laboratory analysis at a frequency of once per month. The following water quality parameters are recommended for analysis:

Potassium (K)	Lead (Pb)	Sodium (Na)	Zinc (Zn)
Alkalinity	pH	Fluoride (F^-)	Arsenic
Bicarbonate (HCO_3)	Chloride (Cl^-)	Boron	Barium
Total Dissolved Solids	Carbonate (CO_3)	Sulfate (SO_4^-)	Calcium
Phenol	Nitrate (NO_3^-)	Oil and Grease	Mercury (Hg)
Electrical Conductivity	Magnesium (Mg)	Ammonia (NH_4^+)	Lithium
Sediment Load (runoff or surface water only)			

5. Embankment Movement - Embankment movement should be monitored at seven locations in the retorted shale pile and at two locations in the raw shale fines pile using slope indicators and establishing benchmarks for transit surveys. Frequency of monitoring should be once per month for several years following construction.

6. Erosion Monitoring Plots - Three plots on the embankment should be marked and monitored to evaluate the effectiveness of the Zone III embankment slope protection layer and the success of the revegetation program.

Monitoring will also be required to gauge the success of revegetation efforts. The State of Utah has defined no specific performance standards for revegetation programs other than a requirement to return the vegetation community to at least 70 percent of its baseline within three years of the onset of revegetation efforts. The following monitoring strategy is recommended:

1. Conduct vegetation transects once per year in the spring to determine abundance and density. Transects should be at least 100 feet long. At selected intervals (10-20 feet), a quadrant should be sampled for all vegetation types.

2. Coordinate the vegetation transects with color IR photographs taken during the same period.

3. Measure and tag individual plants so that an estimate of growth can be made.

4. After the third year, submit a report to the Utah Division of Oil, Gas and Mining that presents the percent revegetation success. If results show less than 70 percent success, further efforts will be required. If results show greater than 70 percent success, the performance bond will be released.

Table 5.1 lists capital and operating costs associated with the monitoring program. As indicated, the total capital cost is $153,900 and the operating labor cost is $15,030 per year or $36,330 for 29 months.

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TABLE 5.1

RETORTED SHALE DISPOSAL AREA MONITORING COSTS

CAPITAL COSTS:

Embankment Movement	$ 41,800
Water Level	18,550
Pile Temperature	57,800
Pile Moisture	15,250
Leachate Sampling	2,500
Revegetation Monitoring (Contract Basis - 3 years)	18,000
Total	$153,900

OPERATING (Monitoring) LABOR:

	HRS/MO
Embankment Movement	16
Water Level	3
Pile Temperature	10
Pile Moisture	6
Leachate Sampling and Lab Analysis	35
Data Tabulation and Reports	18
Erosion Monitoring	2
Total	90*

* 22.5 Hours/Week

(Engineering Technician)

Cost: 22.5/40 x 19,080 (1.40) = $15,030/Year or $313/Week

6.0 ABANDONMENT SCHEDULE:

Table 6.1 presents a schedule for the tasks to be undertaken at the time of abandonment of the Paraho Commercial Plant. As indicated, the bulk of the reclamation work will be completed within eight months of cessation of mining and retort operations. Beyond that time, a limited staff will be required for irrigation and for monitoring associated with the retorted shale disposal area. Table 6.2 presents a summary of abandonment costs.

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TABLE 6.1
ABANDONMENT SCHEDULE

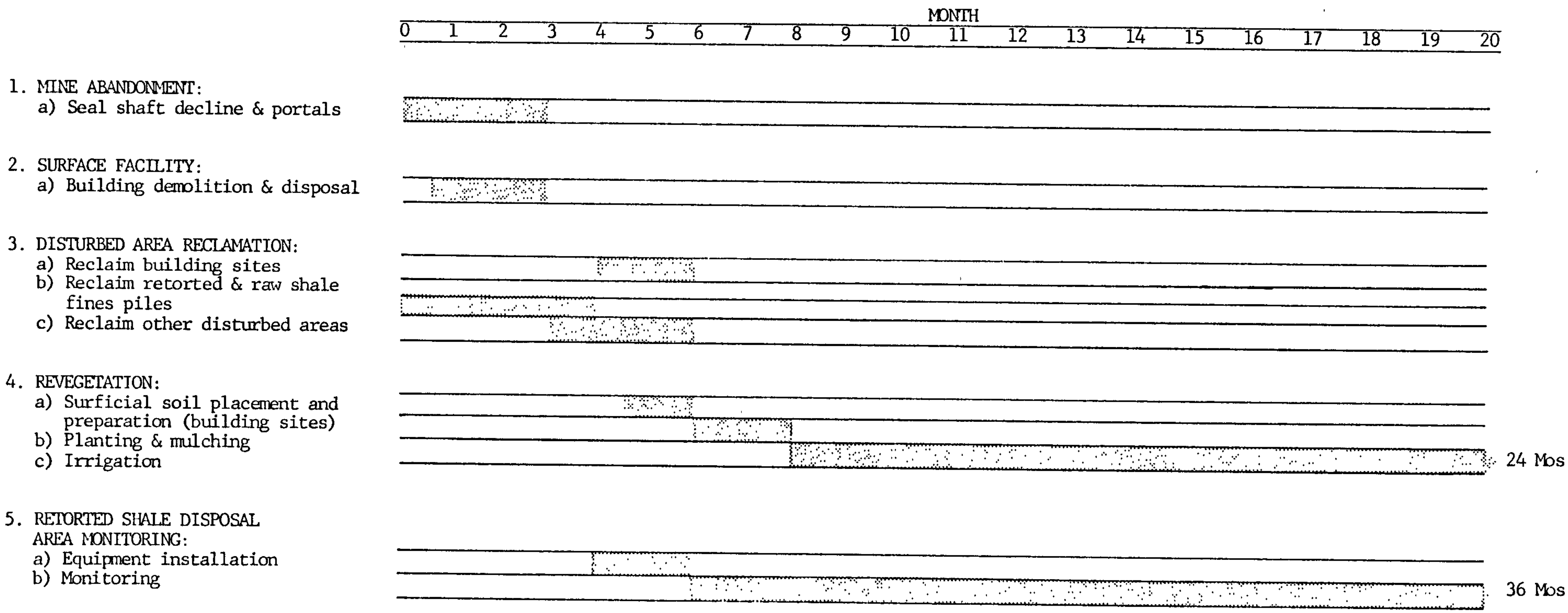

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TABLE 6.2

ABANDONMENT PLAN SUMMARY

ABANDONMENT COST:

Mine Entrance Sealing	$ 113,700
Mine Surface Building Demolition and Removal	1,247,000
Reclamation of Building Site and Disturbed Areas	477,800
Reclamation of Retorted Shale & Raw Shale Fines Piles	2,346,500
Second & Third Years Irrigation & Fertilization	445,250
Retorted Shale Disposal Area Monitoring Labor	36,330
Retorted Shale Monitoring Equipment	153,900
TOTAL COSTS	$4,820,480